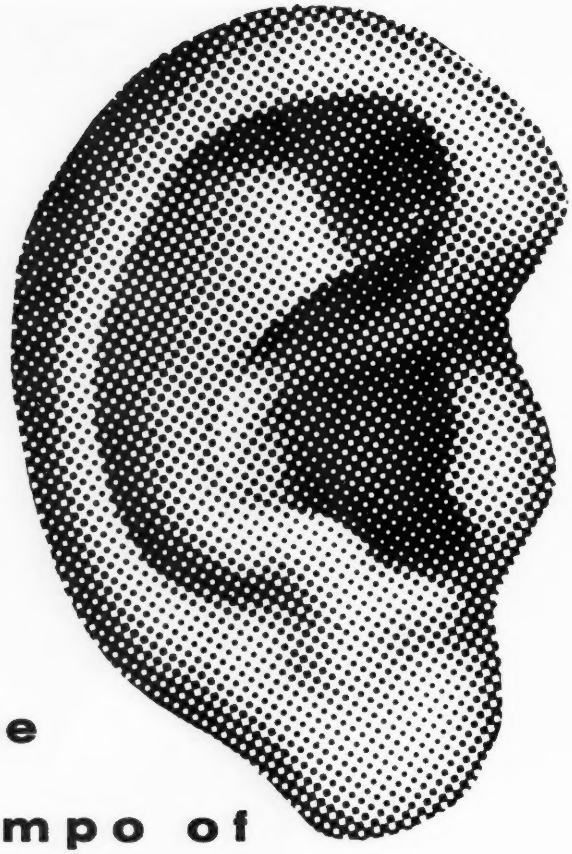
Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY

DECEMBER 1957

ARS ANNUAL MEETING NUMBER

Special 14-page Satellite Report



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Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY, INC.

December 1957 *volume 2* *number 5*

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at press time

Up-to-the-minute news about the rocket, guided missile and jet propulsion fields

MISSILES

• Second prime missile contract held by Minneapolis-Honeywell is for ASROC. Described as an antisubmarine warfare missile, the vehicle, under development by Ordnance Div. of M-H, will have a Librascope fire control system. Universal Match Corp. will supply launch equipment.

Wagtail, an Air Force missile under aegis of M-H Aeronautical Div. is an air-to-ground weapon and employs a relatively simple gyro guidance system.

R&D

• You will be hearing more of an imaginative R&D group called Research Font, Inc., Boston, Mass. Composed of young, well-trained academicians from such well-stocked research reservoirs as M.I.T., Harvard and Tufts, Research Font has already made a name for itself as a consulting firm in the commercial field. It is now setting its sights on space, and has a packaged seven-point program ready for delivery to the Air Force. This includes:

Control of microbiological flora in flight and in space—no doctors, iodine or toothbrushes needed; oxygen conservation and human waste recycling program; miniaturized radiation measuring and telemetering system; a technique for increasing efficiency of human blood in storage and utilization of oxygen; way to use basic human tissues as drug depot areas; blood preservation without refrigeration, and a sleep control program providing for suspended animation for space passengers, prolonged periods of wakefulness, coupled with increased efficiency, for pilots.

• Antigravity lifts its head again. University of Detroit will undertake study to determine whether radiation is or is not associated with gravity. If there is gravitational radiation, the idea is to find some way of counteracting it. U. of D. student newspaper, *The Varsity News,* reports AF has indicated "eager support of the project."

SATELLITES

• Recovering from Russia's one-two satellite punch, the U. S. has made a strong bid to regain the offensive. President Eisenhower, after giving the U.S.S.R. full credit for the scientific achievements implied in successful Sputnik launchings, led from strength in his recent broadcasts to the nation on satellites and security.

• Appointment of James Killian Jr., president of M.I.T., to the newly created post of Special Assistant to the President for Science and Technology, is expected to speed missile development work. In addition, missile czar William Holaday has been given increased authority by the Secretary of Defense and will work closely with Dr. Killian to expedite current missile programs.

• The President also indicated that henceforth all new missile programs, whenever practical and possible, will be placed under a single manager, without regard to the separate services.

• To U. S. missile men, who were more worried by the President's apparent complacency after the launching of Sputnik I than by the deed itself, the significant thing about the message was not only the new awareness but, more important, the excellent over-all grasp of the subject shown by the President.

• Next day, the Army, long clamoring for a chance to get into the space race, was ordered into the satellite program with its Jupiter-C by Defense Secretary Neil McElroy. However, Wernher von Braun, director of Development Operations at ABMA, Huntsville, told the Associated Press that it will take the U. S. "well over five years" to catch up with Soviet satellite development.

• To date, there has been no move made toward increasing present \$38 billion military budget. But, according to Senator Styles Bridges, another \$1 or \$2 billion will probably be put into the pot to speed satellite and missile programs.

• Widespread reactions from Sputnik apparently will spill over into State Dept., which is expected to send science attachés to various U. S. embassies and to revive scientific advisory post in State Dept. at home.

MEETINGS

• Petroleum companies were noticeable by their absence at recent Liquid Bi-Propellant Conference in Sacramento, Calif. Originally called Petroleum Derivable Fuel Conference, the symposium started out on the assumption that the hydrocarbon JP fuels would prove suitable for most rocket work simply with the addition of such things as tetraethyl lead or gasoline.

The assumption proved unworkable, explains one conferee, so it was discarded. The name was changed, and then attendance changed. In place of petroleum firms were such companies as Air Reduction and Stauffer. Among the other 40 attendees were representatives from host Aerojet-General, Rocketdyne, N.A.C.A., New York University, Purdue, General Electric, Bell Aircraft, Reaction Motors and the various branches of the military. The meeting was sponsored by Navy BuOrd.

• Second Symposium on the Physics and Medicine of the Upper Atmosphere and Space is set for San Antonio, Tex., Nov. 10–14, 1958. Host for the meeting will be AF School of Aviation Medicine, and attendance will be by invitation only.

• Provisional Western States Section of the Combustion Institute has rescheduled its meeting for Jan. 20. Tentative program includes papers on diffusion flames and flame stabilization from Stanford Research Institute, Marquardt, North American, Naval Ordnance Test Station and California Institute of Technology.

ROUNDUP

• Commonwealth Engineering Co., Dayton, Ohio, says it has developed "a revolutionary new missile and rocket fuel" that operates on an entirely new principle at temperatures up to 7500 F . . . Du Pont has signed an agreement with Thompson Products whereby Thompson will develop fabricating techniques for new series of niobium metal and alloys now being produced by Du Pont in experimental quantities for possible high-heat applications in missiles . . . Colorado State University has \$163,000 in contracts from The Martin Co. for calibration and evaluation of fuel flow measuring devices for Titan ICBM . . . Amoco Chemicals Corp., recipient of a \$3 1/2-million AF contract for solid propellant jet aircraft starter cartridges, is slated to begin shipments this month . . . Delegation from Los Angeles Chamber of Commerce recently journeyed to Pentagon in an effort to ease economic squeeze on L. A. resulting from payment stretch-out policy of military . . . Lockheed Missile Div. has installed PACE analog computer to speed Polaris program. Computer can virtually "fly" missile designs right off the drawing board, says Lockheed . . . Competition between Boeing and North American for AF contract to build supersonic WS-110A chemical bomber is fast approaching climax. Technical Evaluation team from AF has finished study of both proposals and is about to make decision. Lt. Gen C. S. Irvine terms both designs "major technological breakthroughs" . . . Boeing, meanwhile, has formally opened its new Mach 4 wind tunnel in Seattle . . . North American's new nuclear reactor will be first nonmilitary reactor to produce power commercially . . . First Boeing 707 jet airliner is off the assembly line and undergoing final tests in preparation for its first flight . . . Lockheed's new Mach 17 shock tube is now in operation, testing ballistic missile designs at speeds of 13,000 mph . . . A Snark proficiency training team, consisting of 12 missile specialists from Northrop, is on duty with the 6555th Guided Missile Squadron at Patrick AFB . . . U. of Maryland students, working with S. Fred Singer, have developed a new high-altitude research rocket called Oriol. Rocket uses Loki booster, is said to reach altitudes of 80–120 miles.

capital wire

News highlights from Washington

SPENDING

• Sputnik II swiftens the policy shift toward which the Administration moved reluctantly after the first Soviet satellite. The behind-scenes debate between die-hard economizers and those who think meeting the Soviet challenge demands strong action, whatever the cost will be, was decided in the latter's favor.

• Purse strings will be loosened for research and missile programs, and more attention will be paid to demands of the country's scientific community. But any effort by the Pentagon brass to use Sputnik as a lever to increase strength of conventional forces will be largely unavailing.

• Even before the second Soviet satellite, the Administration had acquiesced in a piercing of its $38 billion ceiling on defense spending for fiscal 1958. Facing facts long known in Pentagon, the President said a $400 million overexpenditure would be allowed in the first half of the fiscal year, admitted the excess would increase before next June 30th.

These were the estimates before the Soviets put a dog in the sky. Now defense spending will likely touch $39 billion this year, may be close to $40 billion for fiscal 1959.

• AF backed away from program that had put its major contractors under a monthly dollar limitation. Loud protests, including some from firms whose bills weren't paid at all, caused the turn-around. Actually, it was a nicely engineered pressure gambit that was instrumental in getting the Administration to hike the over-all spending ceiling.

• AF contractors will still have to finance an increased share of their work in progress. About $500 million is best estimate of burden industry will assume. Government won't pay interest charges per se, but McElroy eased blow by stating that "capital investment by the contractor will be taken into consideration in determining fixed fee or allowable profit."

SPUTNIK II

• Although many press commentators jumped to conclusion that use of exotic fuels enabled Soviets to launch their huge Sputnik II, government rocket experts discounted the possibility. More likely: Use in parallel of powerful rockets Russians are known to possess.

A top Redstone Arsenal scientist pointed out that Soviets have three basic big rocket motors that deliver, respectively, 265,000, 165,000 and 80,000-lb thrust. He suggested that launcher for dog-carrying vehicle might comprise first stage consisting of two 265,000-lb motors, another 265,000-lb motor as second stage, and an 80,000-lb motor for the third stage.

SPY STATIONS

• Publication of long-known fact that U. S. has radar station in Turkey to track Soviet missiles raised a storm and also obscured some facts. Although 3000-mile radar may be available soon, about 1000 miles is limit of today's best. Obviously, station in Turkey can't track long-range missiles over their full course, particularly since launching point is hundreds of miles away.

• Actually, Turkey setup is just one of several ways in which U. S. monitors Soviet missile progress. Details are top secret, but there's speculation that interception of Soviet missile telemetering may be involved. Also possible: Special equipment involving electromagnetism that makes it possible to follow bodies moving around the earth.

MISSILES

• Some reorganization of the missile effort is likely, but a super-agency along Manhattan Project lines remains only a long-shot possibility. Most officials think it would do more harm than good.

• Navy is under pressure from Capitol Hill to accelerate its Polaris program. While missile itself is reported making excellent progress, there's concern that Navy may be slow in scheduling nuclear-powered submarines to carry the weapon.

Suggestion has been made that Navy convert one or more of the nuclear subs already on the way for Polaris. Some officials prefer step-by-step program, involving firings from surface test ship, before committing themselves to an extensive sub program. But impatient advocates of "ballistic seapower" are pushing for full speed ahead—a gamble that the missile-submarine team will work well.

AICBM

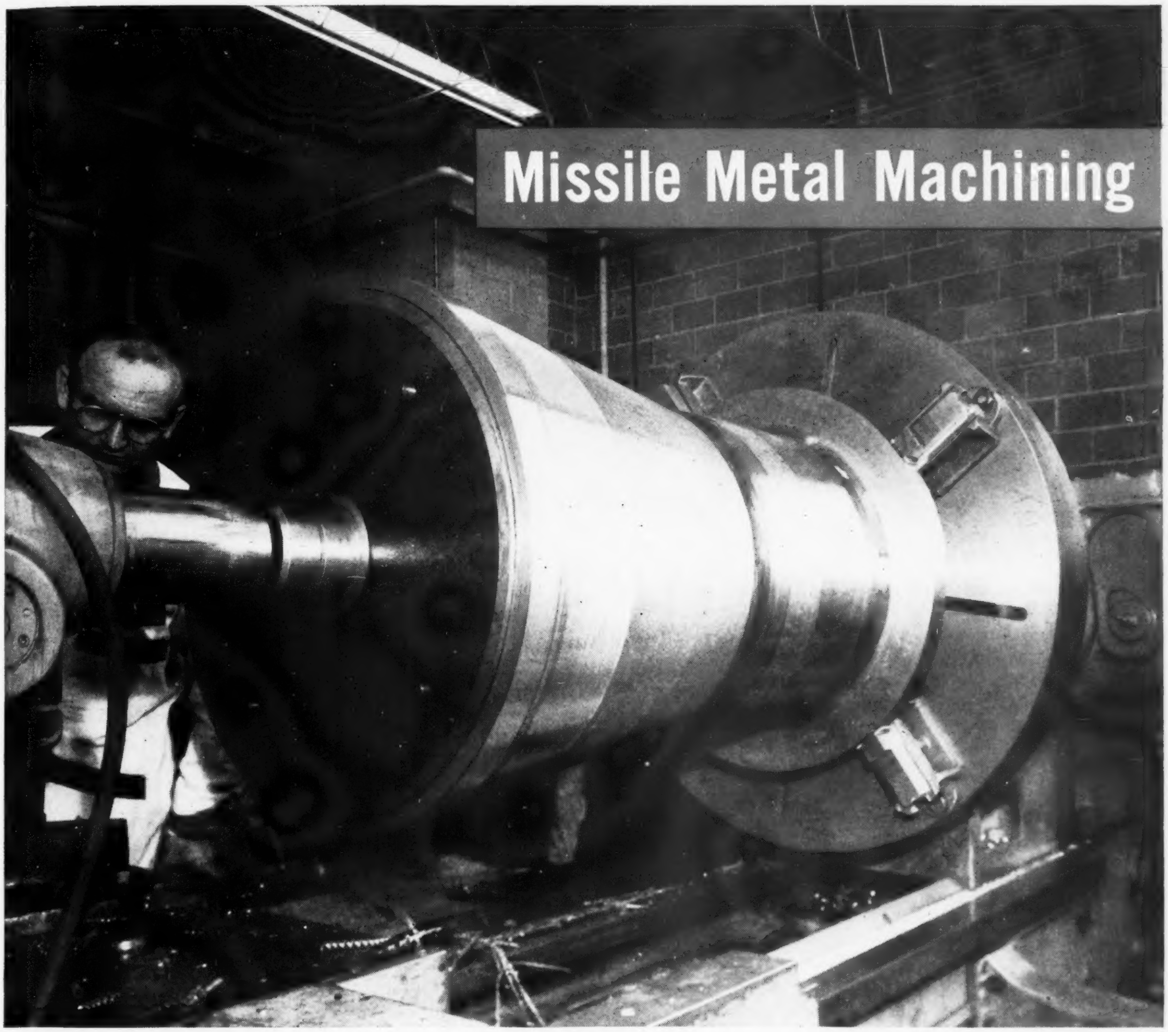
• Dramatic action on the anti-missile missile may be in offing. While super-agency for entire missile effort is in disfavor around Pentagon, chances are good that—before it's too late—work on anti-ICBM will be centered in a special group.

• Officials admit interservice rivalry has damaged U. S. missile program; it's already a factor in connection with the AICBM. Defense Secretary McElroy, who told subordinates at recent Armed Forces Policy Council that he'll tolerate no warfare among the services, may beat the game so far as the AICBM is concerned by setting up a special unit to work on the problem.

SATELLITES

• Restoration of slashed research funds—and brightened outlook for more research money—caused services to dust off satellite programs. AF went to work on plans for TV-equipped satellite that would weigh in at about 1500 lb. Army offered $3.5 billion program to build similar vehicle within three years that could photo-survey entire U.S.S.R. every 48 hours.

• So far, however, pressure is mainly from the bottom—ambitious "Indians" at the working level. But second Sputnik will heighten interest among policymakers.


Missile Metal Machining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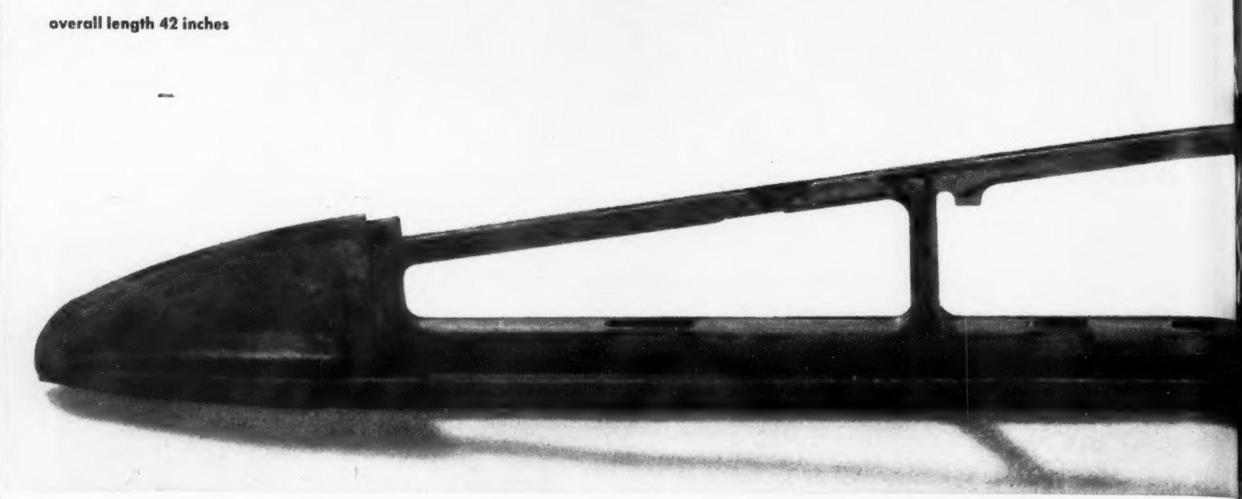
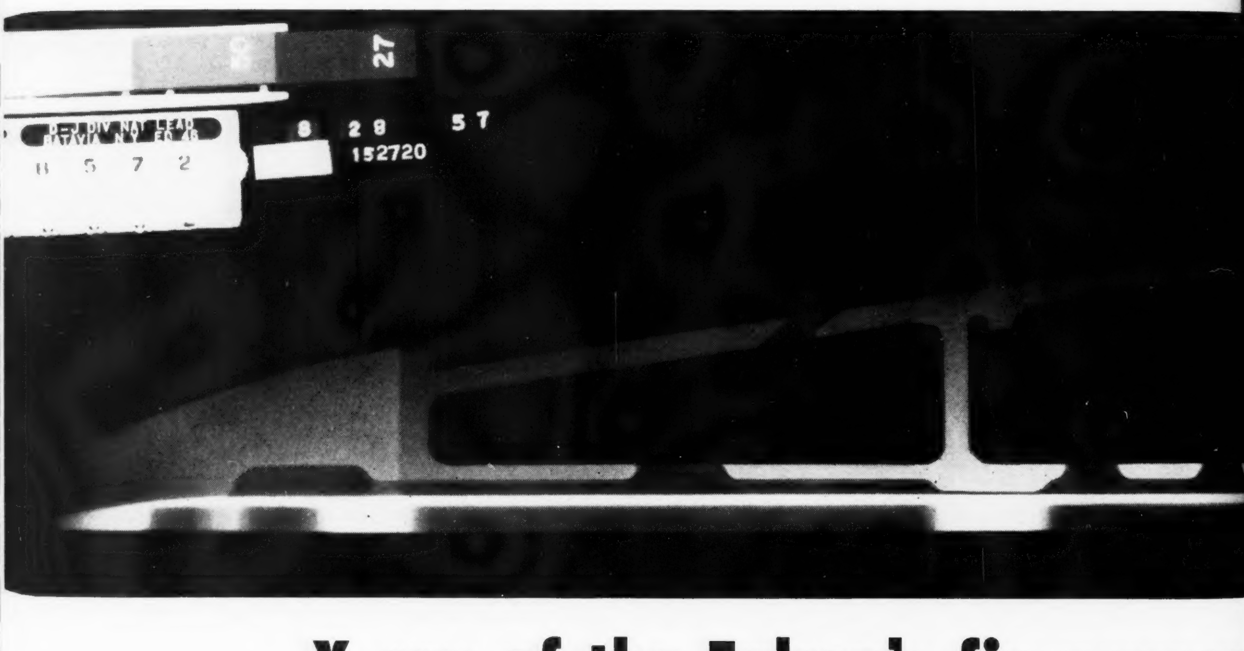


Now...from Doehler-Jarvis...die castings



X-ray of the Falcon's fin proves

The Falcon is an air-to-air missile built by Hughes Aircraft Company for the U. S. Air Force. Its light weight die cast stabilizer fins resist severe strain during course changes. It uses other Doehler-Jarvis die castings also.

Now *you* can have structurals die cast to standards as high as those for primary aircraft structurals*.

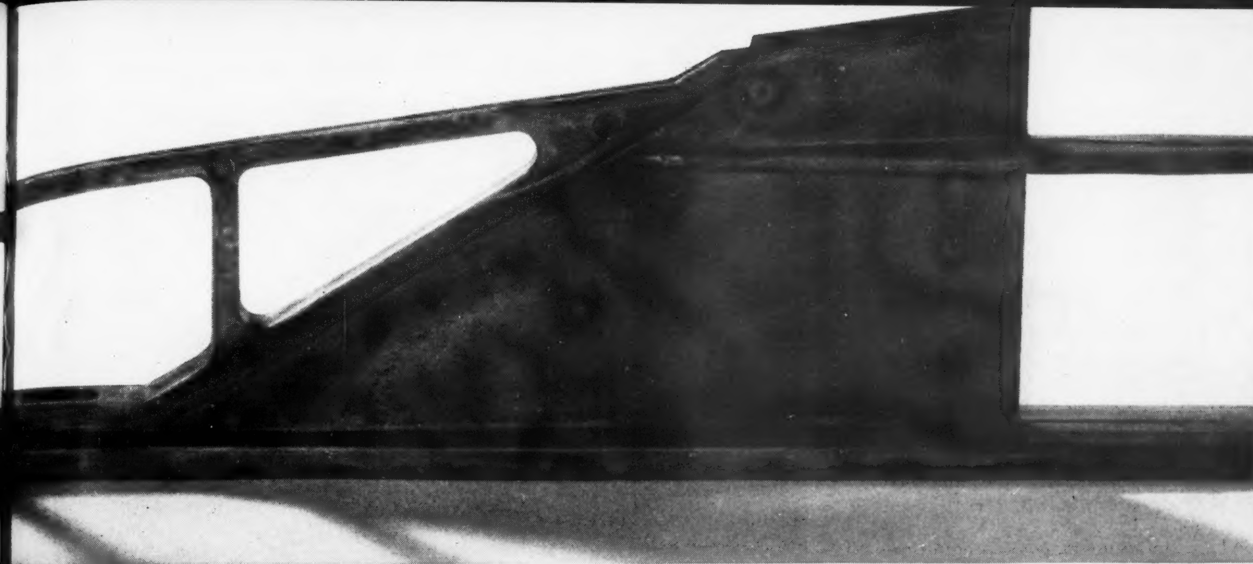
Die cast! With all the economy, precision, surface superiority, ease of assembly that implies. Die cast of aluminum, or of a high-purity magnesium alloy, like the 42" Falcon stabilizer fin.

They said it couldn't be done!

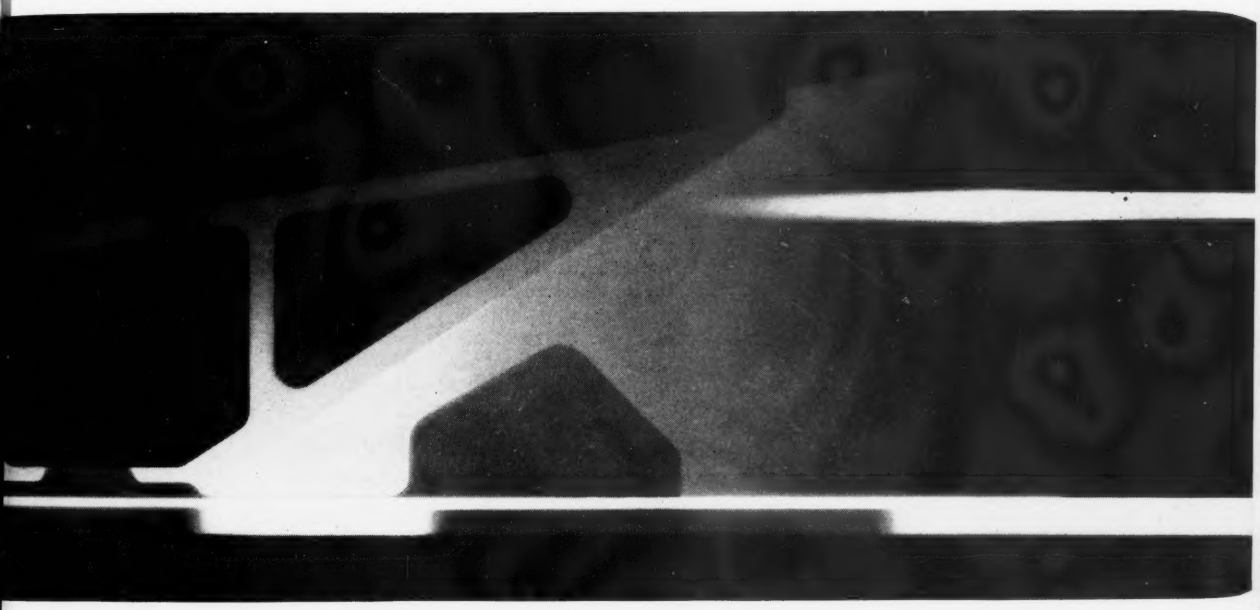
But there you see such a structural! Along with X-ray proof of soundness, uniformity, primary-aircraft-structural* quality.

Mind you! The Falcon fin is in commercial production. Doehler-Jarvis has die cast thousands. Each has had to pass 73 inspections before acceptance . . . including 100% X-ray.

In *one* control, sections of castings are continuously tested for tensile strength. In this examination of physical properties, the castings normally exceed tensile specifications by 15% or



# of primary-aircraft-structural* quality



their uniformity and soundness

more. Quality is so high there has never been a single test below specification.

How did this come about?

Like many developments in die casting, this one started with a customer's need . . . Hughes Aircraft's.

They, and the Armed Services, needed such castings. The parts *might* be made other ways. But at what cost! What sacrifice in weight — and materials! If it *could* be die cast, if there *were* a magnesium alloy able to stand supersonic air stresses . . .

It took a while. But, with close cooperation from engineers of both Doehler-Jarvis and Hughes, the way was found.

Now you can list die castings of primary-aircraft-structural* quality among D and J availabilities. Get them from any Doehler-Jarvis plant.

*A primary aircraft structural is a major load-bearing component member any single failure of which would result in loss of the aircraft.

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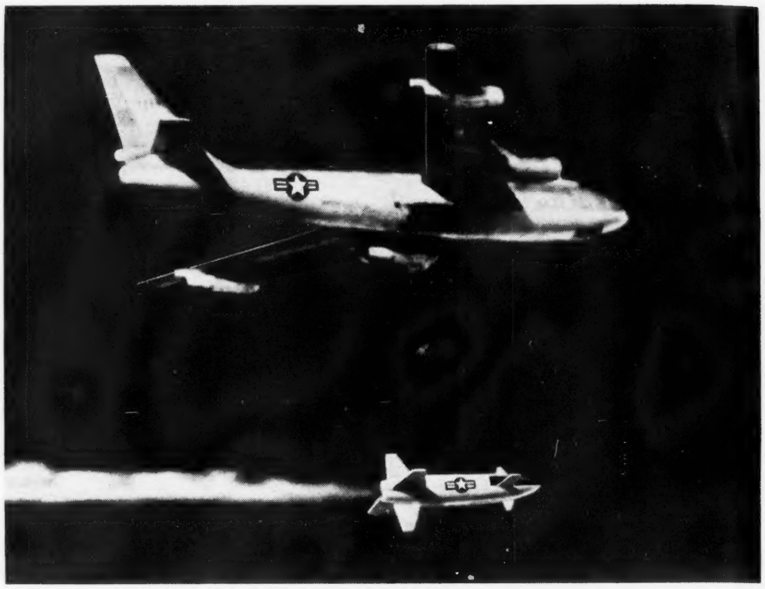
Missile Security Curtain Raised in Wake of Sputnik

In the wake of Sputnik, information on U. S. rocket and missile firings has been pouring out of the Defense Department almost on a day-to-day basis in an intensive effort to acquaint Americans with our own accomplishments in these fields.

• Satellites: Both DOD and Patrick AFB issued statements on the successful firing of the third Vanguard test vehicle (TV-2) at Cape Canaveral, Fla. The vehicle, first to have the external configuration of the final Vanguard launching vehicle, rose to 109 miles, attaining a peak speed of 4250 mph. No attempt to launch a satellite was made, and primary purpose of the firing was to test the first-stage engine and instrumentation. The second and third stages were dummies.



GAM-63 Rascal air-to-surface missile drops from B-47 in test over AF Missile Development Center in New Mexico.

Firings Due This Month

Firing of four more test vehicles (TV-3 through TV-6) is scheduled for this month, although there were some indications that they might be moved up in an effort to speed the program. The vehicles will carry the 6-in. test satellites, which might be placed in orbit. Launching of the fully-instrumented 20-in. satellite is now slated for early next year.

• Farside: The Air Force, after several unsuccessful attempts at launching a rocket from a balloon platform 100,000 ft above Eniwetok Atoll in the Pacific in Project Farside, finally managed to fire two of the four-stage rockets, and claimed a new altitude record as a result. On the basis of radio data received, AF spokesmen estimated that one of the rockets had attained an altitude of at least 2700 miles.

• IRBM's: Both the Army's Jupiter (twice) and the AF Thor were successfully fired from Cape Canaveral, and on each occasion DOD announced that the missile had been tested and actually named it and gave a few details—a departure from previous practice.

Meanwhile, Rear Adm. W. F. Raborn, Director of Polaris Development for the Navy, said the missile was making "amazing" progress and expressed the hope that it would be in service not long after its land-based relatives.

• Other Missiles: An AF Bomarc IM-99 long-range interceptor missile launched at the AF Missiles Test Center in Florida destroyed a B-17 drone more than 100 miles out over the Atlantic at a height of more than 60,000 ft. Although tests of this type are scheduled for near misses which are recorded by cameras in the drone, the Boeing-built missile followed the target so closely in this instance that it was destroyed by collision.

The Sidewinder air-to-air missile, which employs an infrared homing system, was successfully tested against a target plane with a flaming flarepot on its wing. The Philco missile homed on the flame, and destroyed the target.

The GAM-63 Rascal air-to-surface missile racked up a score of four direct hits on a target with a radius of only 1500 ft in a series of tests at the AF Missile Development Center in New Mexico. The Bell missile was launched from a B-47 bomber flying over the integrated test range. Distance from launch to target was not disclosed. The AF missile is due to become operational with the Strategic Air Command shortly.

A Snark fired at Cape Canaveral reportedly "went the distance"—5000 miles to a point near Ascension Island. Movement of highly instrumented ships to stations along the missile range lent credence to the report, also indicate officials are hopeful there will be quite a few very-long-range vehicles to track before too long.

Advanced Propulsion Systems Meeting Set for Dec. 11-13

Three hundred leading scientists will review technical progress in the development of advanced propulsion systems in a closed Los Angeles meeting Dec. 11–13.

Sponsored jointly by the AF Office of Scientific Research of ARDC and Rocketdyne, a division of North American Aviation, Inc., the symposium includes seminars on advanced methods of producing thrust, component problem areas and high energy propellants.

A single unclassified meeting is scheduled for the evening of Dec. 12. J. H. Kindelberger, North American board chairman, will act as master of ceremonies.

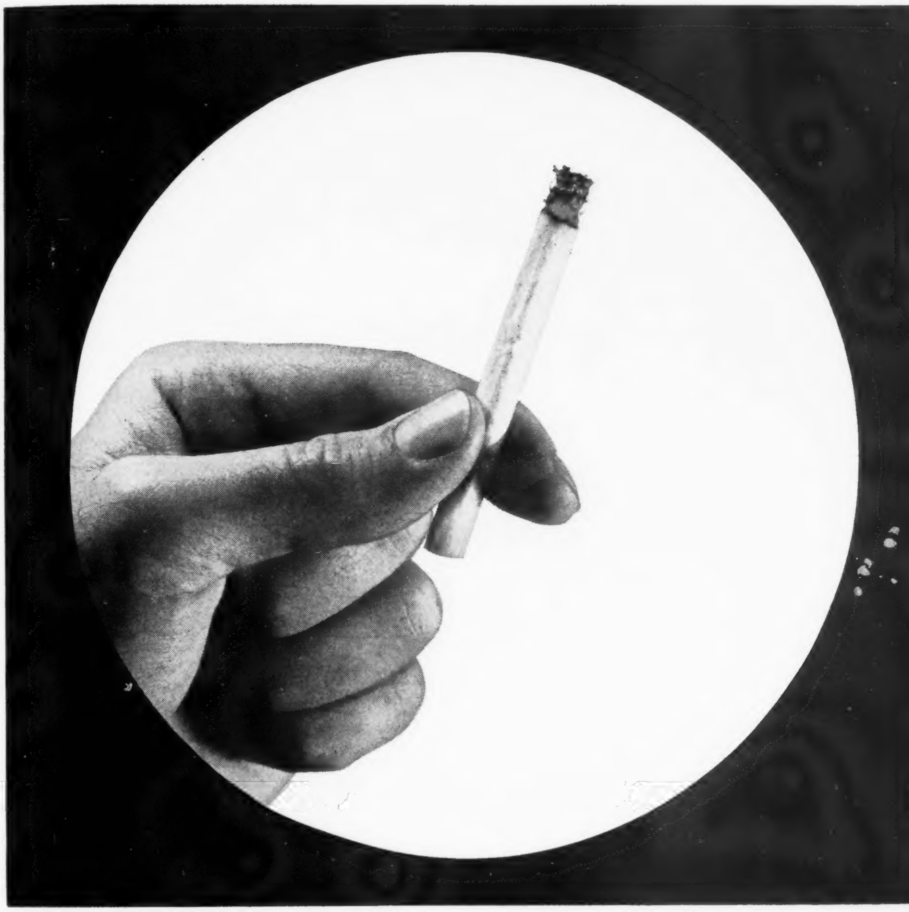
Co-chairmen of the symposium are Morton Alperin, Director of Advanced Studies, AFOSR, and George P. Sutton, Chief of Preliminary Design at Rocketdyne.

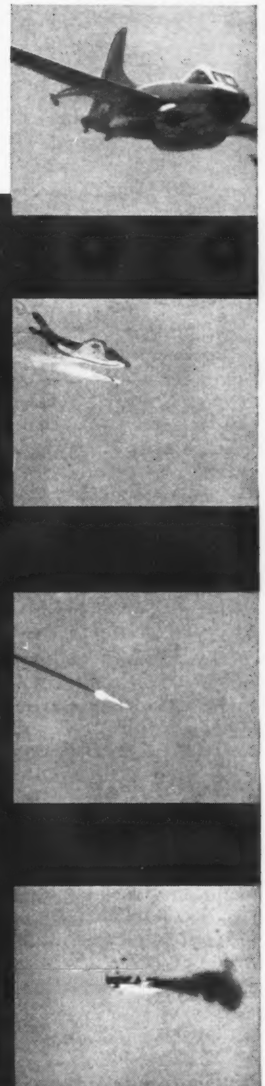
Attendance will be limited to representatives of organizations working directly on advanced propulsion systems.

Two-Stage Test Rocket Fired in Australia

An Australian two-stage rocket reached an altitude of 80 miles in a successful test firing Oct. 30 at the Woomera missile test range. Instrumentation carried in the rocket was recovered. Australian officials said the firing was part of a program to test missile tracking equipment.

Invitation to **SUDDEN DESTRUCTION**





Defender plane, armed with wing-mounted Sidewinder missiles pursues target . . . Sidewinder is fired . . . guided by infra-red, the missile "homes" on target . . . bringing sudden and inescapable destruction.

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19 Countries Represented at IAF Meeting in Barcelona

BARCELONA, SPAIN—Representatives of 19 countries—the U. S., Spain, Great Britain, Poland, Germany, the U.S.S.R., Italy, France, Austria, Sweden, Switzerland, Yugoslavia, Holland, Belgium, Denmark, South Africa, Canada, Argentina and Brazil—attended the 8th International Astronautical Federation Congress here early in October.

The U. S. and Spanish groups were by far the largest, each with 38 delegates. The U.S.S.R. was represented by Prof. Leonid I. Sedov, who headed the delegation; Lydia Kurnosobra, cosmic radiation expert; A. T. Masevich, an astrophysicist; and Anatalio Karpienko, a physicist.

Many of the American papers were abstracted in the November ASTRONAUTICS (page 36). This report will therefore be concerned with other American papers which were not received early enough for inclusion in last month's story, and with some of the foreign papers of interest.

The paper on "Sodium Emission at 140 Km," by E. R. Manning and J. F. Bedinger of the AF Cambridge Research Center told of experiments centered on the release of atomic sodium vapor from Aerobee rockets while climbing from 50 to 140 km. The sodium burned brightly at these heights, the yellow glow lasting 2 sec at 50 km, increasing in duration to 15 sec at 100 km and vanishing at 130 km. The authors suggested that night airglow, which is of the same color, may be caused by sodium from meteoritic dust.

Weightlessness Discussed

Weightlessness was discussed in a paper by Siegfried Gerathewohl and others from the AF School of Aviation Medicine, but in this instance the paper was concerned with the means for producing the weightless state in jet aircraft, rather than with a consideration of physiological and psychological effects.

Two papers dealt with the balloon flight to 100,000 ft by Maj. David G. Simons. The papers were illustrated by color films, one taken by Maj. Simons from inside the gondola.

Andrew G. Haley, newly elected IAF President, presented a paper which attempted to define the boundaries between air law and space law. He fixed this boundary at 270,000 ft, or about 52 miles.

Four Russian papers were presented. These dealt with satellite orbits, lifetimes and instrumentation, and were similar to, if not identical with, papers presented a month earlier at the IGY rocket and satellite meeting in Washington. Scientists present at the meeting found the papers to be of no particular significance.

In private discussions with American delegates, Prof. Sedov said the Russian satellite was not spinning, and intimated that an alcohol-LOX combination had been used in the Sputnik launching vehicle.

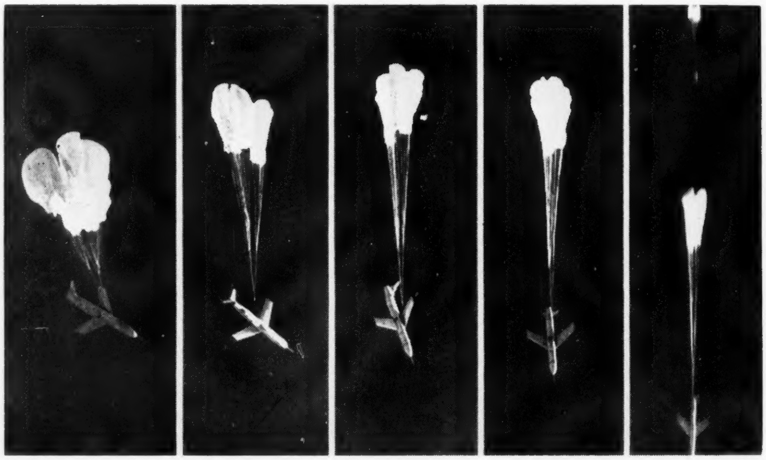
Two British Papers Presented

The two British papers were "The Problem of Variable Thrust," by Wilfred N. Neat of De Haviland, and "The Probability of Intelligent Life Evolving on a Planet," by A. E. Slater.

The Neat paper dealt with the problems involved in attempting to throttle down liquid rocket engines. The author noted that reducing propellant flow leads to cooling problems, as well as to coarser atomization of propellant. Using a number of small rocket engines and throttling them down one by one makes it difficult to keep the thrust centralized, but may offer one solution.

The Slater paper regarded it as highly improbable that intelligent life on the human level would be found on any other planet, the assumption being it was unlikely that the same long series of unlikely events leading to the evolution of man on earth would be duplicated elsewhere.

Preprints of all American papers presented at the Barcelona meeting are now available from ARS headquarters.



Missile Letdown

Latest version of Martin's TM-76 Matador, as shown in this sequence, incorporates recovery parachutes so that the former one-shot missile may be re-used in training and test flights. In level flight, a small extraction chute comes out first, followed by three 100-ft cargo chutes. As the cargo chutes catch air, the missile is slowed, and then starts pointing upward. After forward motion has stopped, the chutes float the missile safely to the ground.

Linde Lends a Hand To Wyle Test Facility

Wyle Laboratories, El Segundo, Calif., is building a high-flow liquid and gaseous oxygen facility for testing missile components and systems. The facility will also be used for cleaning and packaging components destined for operational use. Initial operation is slated for some time this month.

The purpose of the plant, according to Wyle, is to avoid costly duplication of such facilities by contractors and their suppliers, who need them for performance testing of missile components under flight conditions.

Linde Co., a division of Union Carbide Corp., is providing technical assistance on the project and, when the unit is in operation, will supply the required liquid oxygen and nitrogen from its Fontana plant.

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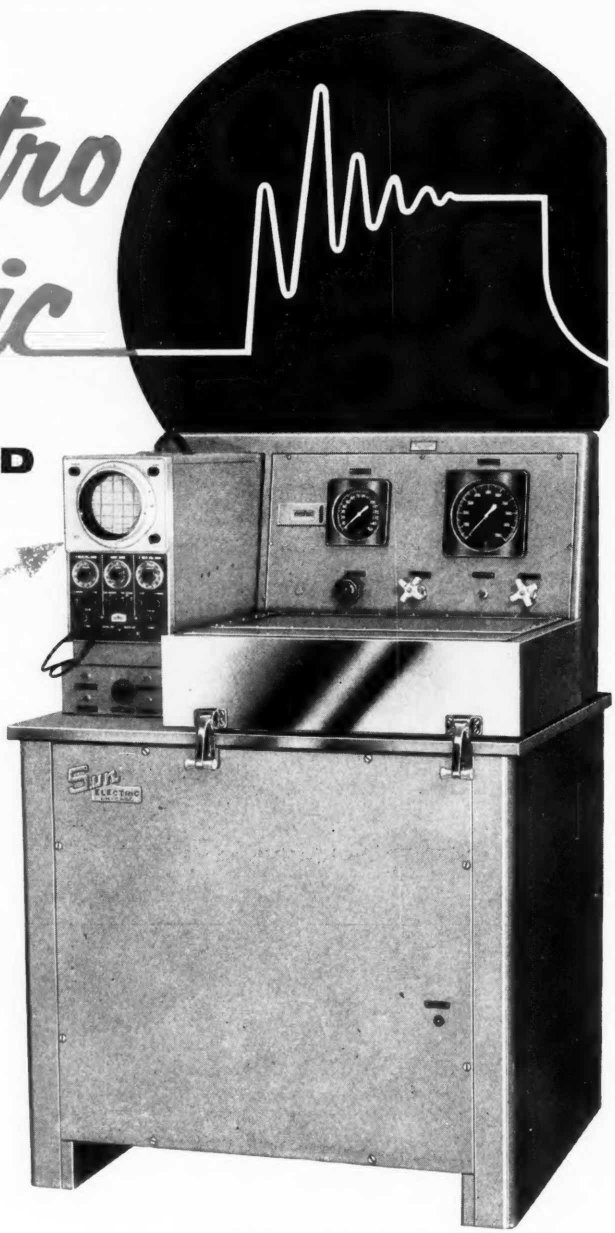

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Length: 40 in. — Width: 30 in. Height: to table top 36 in. overall: 56 in. Electrical Requirements: 115 volt, 60 cycle A.C. Air Pressure: 55-90 psi. Hydraulic Fluid: Monsanto OS-45. Reservoir Capacity: 2 gallons. Test Chamber Heater: 2000 watts. Test Chamber Fire Extinguisher: CO_2 actuated at 250°F.

Sun ELECTRIC CORPORATION

CHICAGO AERONAUTICAL DIVISION: 6326 Avondale Ave., Chicago 31, Illinois
LOS ANGELES AERONAUTICAL DIVISION: 6704 Sepulveda Blvd., Los Angeles, California

COVER: *Karl G. Henize, Smithsonian Observatory astronomer in charge of IGY satellite photographic tracking stations, makes an adjustment on the Nunn-Baker telescope camera, now being used to track Sputniks (see page 40). This exclusive color photo of the camera was taken by Charles Kassler.*

Astronautics

DECEMBER 1957

A Preview—and a Welcome

The 12th annual meeting of the American Rocket Society, to be held at the Hotel Statler in New York December 2–6, could not be more timely.

With two man-made satellites circling overhead as constant reminders of what lies in the future, the need for an American Rocket Society and meetings of this kind has become self-evident.

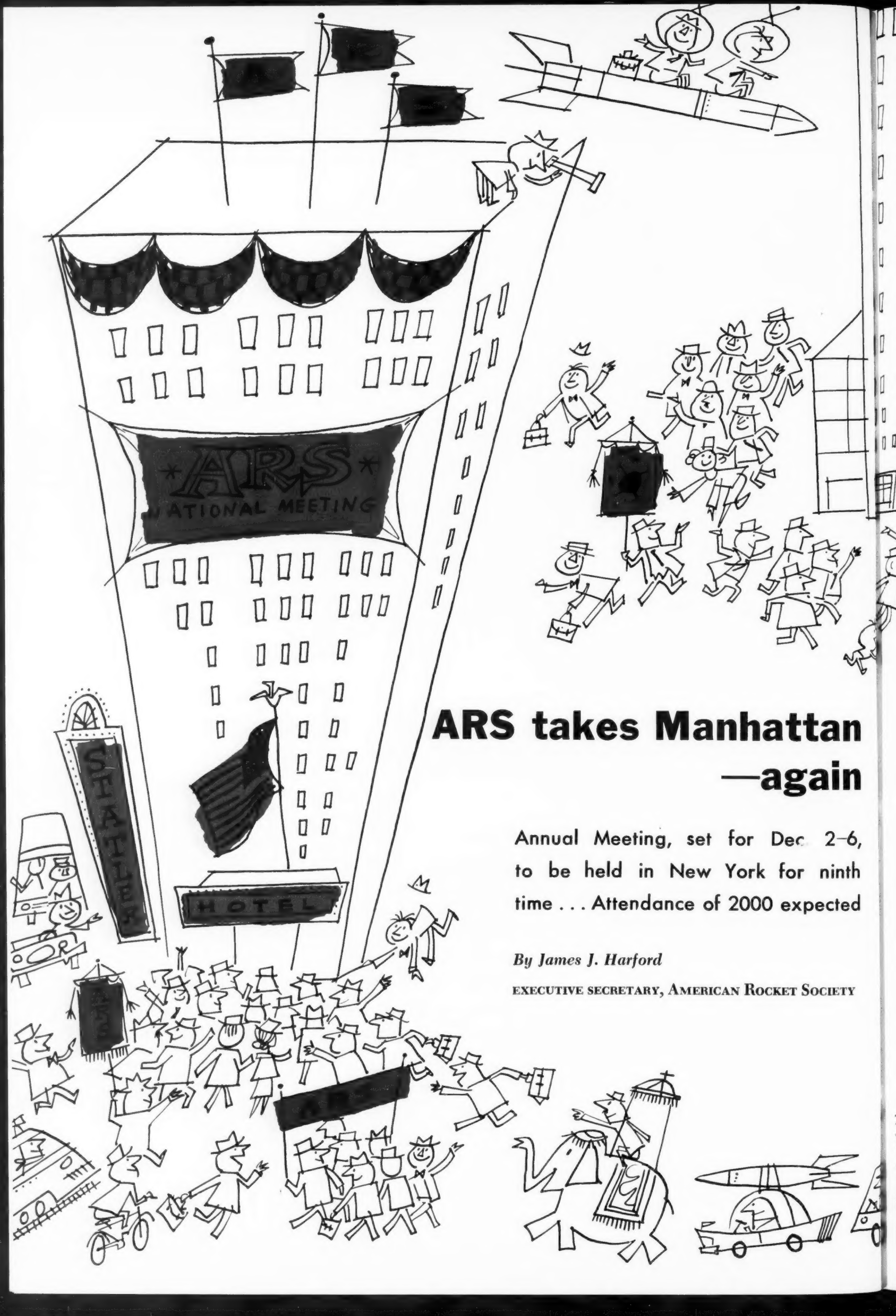
It is therefore appropriate that the program for the meeting should be the biggest and most diversified ever offered. Program highlights are almost too numerous to mention, but certainly the 15 technical sessions, now broadened to include subjects ranging all the way from guidance and instrumentation to human factors in space flight, the Rocket and Satellite Exhibit at the New York Coliseum, and addresses by three distinguished speakers—Brig. Gen. H. F. Gregory, Chief of the AF Office of Scientific Research; William M. Holaday, Special Assistant to the Secretary of Defense for Guided Missiles; and Joseph Kaplan, Chairman, USNC-IGY—would stand out at any meeting.

There will be other attractions as well—the first ARS Eastern Regional Student Conference, the first classified session ever presented at a national meeting, the annual Honors Night Banquet, among many others—and, of course, the informal "bull sessions" which often prove so productive.

With public interest in rockets, guided missiles and space flight greater than ever before, press coverage of the event will in all likelihood far exceed that of previous ARS meetings. Certainly, the meeting provides a unique opportunity to learn what American engineers and scientists in these fields are doing, and why.

Present indications are that attendance at the meeting will reach an all-time high. It is indeed a pleasure to welcome the many members, guests and friends of the American Rocket Society to what promises to be the most important meeting in the Society's 27-year history.

Robert C. Truax
President, American Rocket Society

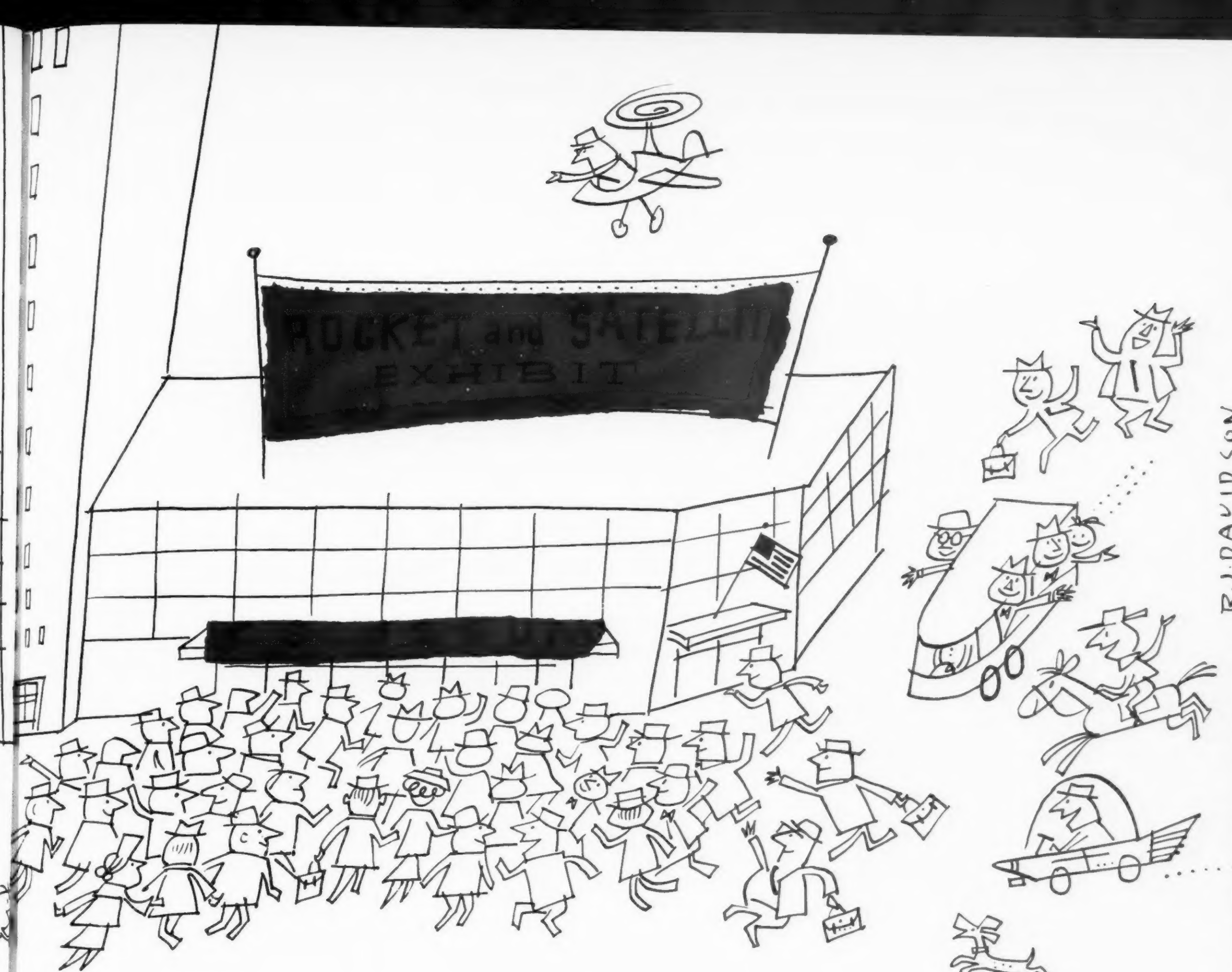


ARS takes Manhattan —again

Annual Meeting, set for Dec. 2–6, to be held in New York for ninth time . . . Attendance of 2000 expected

By James J. Harford

EXECUTIVE SECRETARY, AMERICAN ROCKET SOCIETY



JUST 11 years ago, on Dec. 5–6, 1946, the AMERICAN ROCKET SOCIETY held its First Annual Meeting at what was then the Hotel Pennsylvania in New York. This year's Twelfth Annual Meeting will be in the same hotel, now the Hotel Statler, and the same week, running from Dec. 2 to 6. The differences between the two meetings testify to the phenomenal things that have happened to ARS and its field in that short space of time.

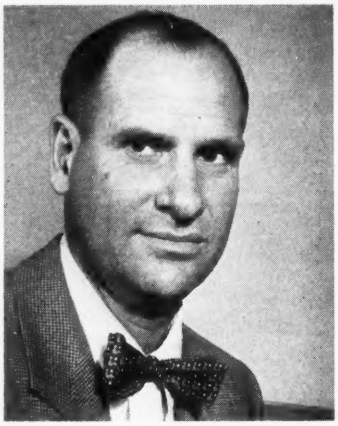
The full program for this year's meeting starts on page 24. The 15 technical sessions, 114 authors and panel members, three luncheons, annual business meeting, Section Delegates Conference, film night, Honors Night Dinner, Student Conference, and 55-booth exhibit, provide a sharp contrast to the 1946 meeting, which had three sessions, 10 authors, one luncheon and one dinner.

The ARS that produced the 1946 meeting had 507 members and had not yet established a single regional Section. By the time you read this, the Society's membership will have passed the 7000 mark and the next Section formed will be the 36th.

The only member of today's headquarters staff who has the qualifications to remember, Secretary A. C. "Billie" Slade (who took on a "part-time" job with ARS during 1946), dusted off her archives the other day to find that attendance at the 1946 meeting was around 200. Some 2000 are expected to register this year. Other then-and-nows:

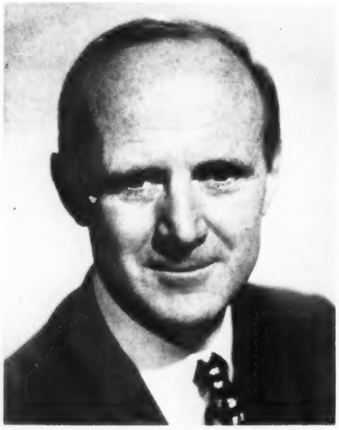
* A paper on liquid rocket motors was presented

AWARD WINNERS TO BE HONORED AT BANQUET

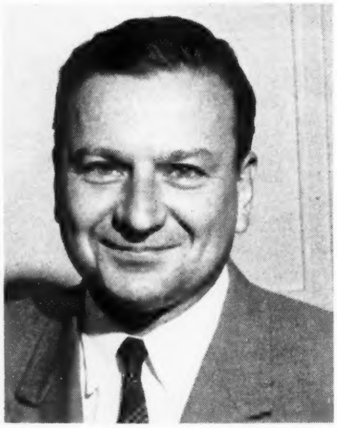


Thomas F. Dixon
Rocketdyne
Robert H. Goddard Memorial Award

Capt. Levering H. Smith (USN)
Polaris Project
C. N. Hickman Award



William H. Pickering
Jet Propulsion Laboratory
James H. Wyld Memorial Award



Krafft A. Ehricke
Convair
ARS Astronautics Award

Capt. Grayson Merrill (USN-Ret.)
Fairchild Guided Missiles Div.
G. Edward Pendray Award

in the '46 program by the late James H. Wyld of Reaction Motors. This was when production of rocket motors was spoken of in single units. The Wyld Memorial Award is offered this year to William H. Pickering of Cal Tech's Jet Propulsion Laboratory, an outstanding contributor to many rocket and guided missile programs, not the least of which is the Corporal, now in operational use by the hundreds in the U. S. and Europe.

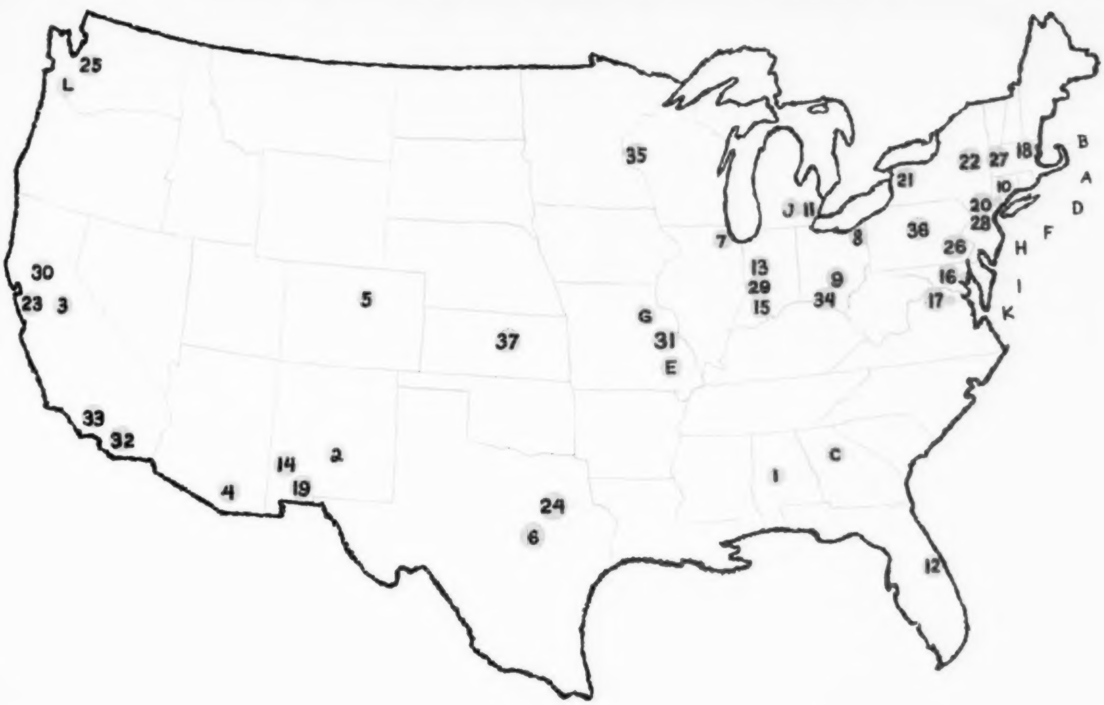
° A Navy Commander named Grayson Merrill gave a paper in 1946 on the Navy's tests of such primeval birds as Loon, Gargoyle, Gorgon. On Dec. 5, Capt. Grayson Merrill (USN Ret) and now director of engineering at Fairchild Guided Missiles Div., will be chairman of a Space Flight Session that covers such esoteric subjects as "On Catalytic Recombination Rates in Hypersonic Stagnation Heat Transfer." That evening, Capt. Merrill will receive the G. Edward Pendray Award for the fine series of books on guided missiles he edited for D. Van Nostrand Co.

° Speaker at the 1946 luncheon was C. N. Hickman, then with Bell Labs. His topic was development of rocket projectiles. The same Dr. Hickman will present the Hickman Award this year to Capt. Levering Smith for his outstanding contribution to the Polaris program. The range of Dr. Hickman's projectiles was measured in yards. Range of the solid propellant Polaris is reported to be 1500 miles.

° The author of a 1946 paper on long-range rocket bombs, Major H. L. Karsch of White Sands Proving Ground, today finds himself running a project with considerably longer range. He's on Project Farside for Aeronutronics. Range: 4000 miles.

Conspicuous in this year's program is the work of the seven Technical Committees which are just short of one year old. Appointed by President Robert C. Truax, their efforts were coordinated this

ARS SECTIONS COVER THE COUNTRY



SECTIONS

1. Alabama—Cliff E. Fitton Jr., President
2. Albuquerque*
3. Antelope Valley—Richard A. Schmidt, President
4. Arizona, Sydney Wade, President
5. Central Colorado—John R. Youngquist, President
6. Central Texas—E. F. Fiock, President
7. Chicago—John Krc Jr., President
8. Cleveland-Akron—Luis R. Lazo, President
9. Columbus—Abbott A. Putnam, President
10. Connecticut Valley—Charles H. King Jr., President
11. Detroit—Lovell Lawrence Jr., President
12. Florida—R. L. Yordy, President
13. Fort Wayne—Roy Jackson, President
14. Holloman—Knox Millsaps
15. Indiana—W. H. Munyon, President
16. Maryland—Samuel Fradin, President
17. National Capital—Erik Bergaust, President
18. New England—Lawrence Levy, President
19. New Mexico-West Texas—George L. Meredith, President
20. New York—Robert A. Gross, President
21. Niagara Frontier—Harry A. Ferullo, President
22. Northeastern New York—T. C. Swartz, (Acting) President
23. Northern California—A. K. Oppenheim, President
24. North Texas—George H. Craig, President
25. Pacific Northwest—W. Emmett Coon, President
26. Philadelphia—Abe Bernstein, President
27. Pittsfield*
28. Princeton—John B. Fenn, President
29. St. Joseph Valley—C. M. Shaar Jr., President
30. Sacramento—Daniel M. Tenenbaum, President
31. St. Louis—Robert A. Cooley, President
32. San Diego—William H. Dorrance, President
33. Southern California—James A. Broadston, President
34. Southern Ohio—T. P. Meloy, President
35. Twin Cities—C. C. Chang, President
36. University Park—John Fox, President
37. Wichita—Lawrence J. McMurtrey, President

STUDENT CHAPTERS

A. Academy of Aeronautics—Frank Ford, President
B. Boston University*
C. Georgia Tech—Morton Metersky, Chairman
D. New York University—Robert E. Huber, President
E. Parks College of Aeronautical Technology—
Gerald Chmielewski, President
F. Polytechnic Institute of Brooklyn—Fred Schuyler, President
G. Southern Illinois University*
H. Stevens Institute of Technology*—Richard Nelson, President
I. United States Naval Academy*
J. University of Michigan—J. B. Bullock, President
K. University of Virginia*
L. University of Washington*

* In process of formation.

New York Coliseum, scene of the ARS Rocket and Satellite Exhibit

year by National Program Chairman Kurt Stehling.

The Society owes much to Chairman Stehling, the committees, their chairman, and to the organizations which helped make it possible for them to devote the time they put into their jobs. These are some of the individuals to whom we hereby offer our thanks:

Solid Rockets	William L. Rogers, Aerojet-General Ivan Tuhy, The Martin Co.
Propellants and Combustion	John F. Tormey, Rocketdyne
Ramjets	Brooks Morris, Marquardt William Shippen, Applied Physics Lab.
Instrumentation and Guidance	John J. Burke, Hallamore Electronics William Strang, Convair
Space Flight	Krafft Ehricke, Convair Andrew G. Haley
Liquid Rockets	Col. Edward N. Hall, ARDC Y. C. Lee, Aerojet-General
Human Factors	Maj. David G. Simons, Holloman AFB

They are responsible for coming up with excellent sessions in fields which ARS has perennially covered well—propulsion and space flight—and adding new breadth and depth to the meetings with fine sessions covering such subjects as space cabin development, manned balloon flights, weightlessness, infrared and inertial guidance, radio instrumentation of satellites, packaging of guidance systems, ICBM telemetry and closed circuit television of rocket tests.

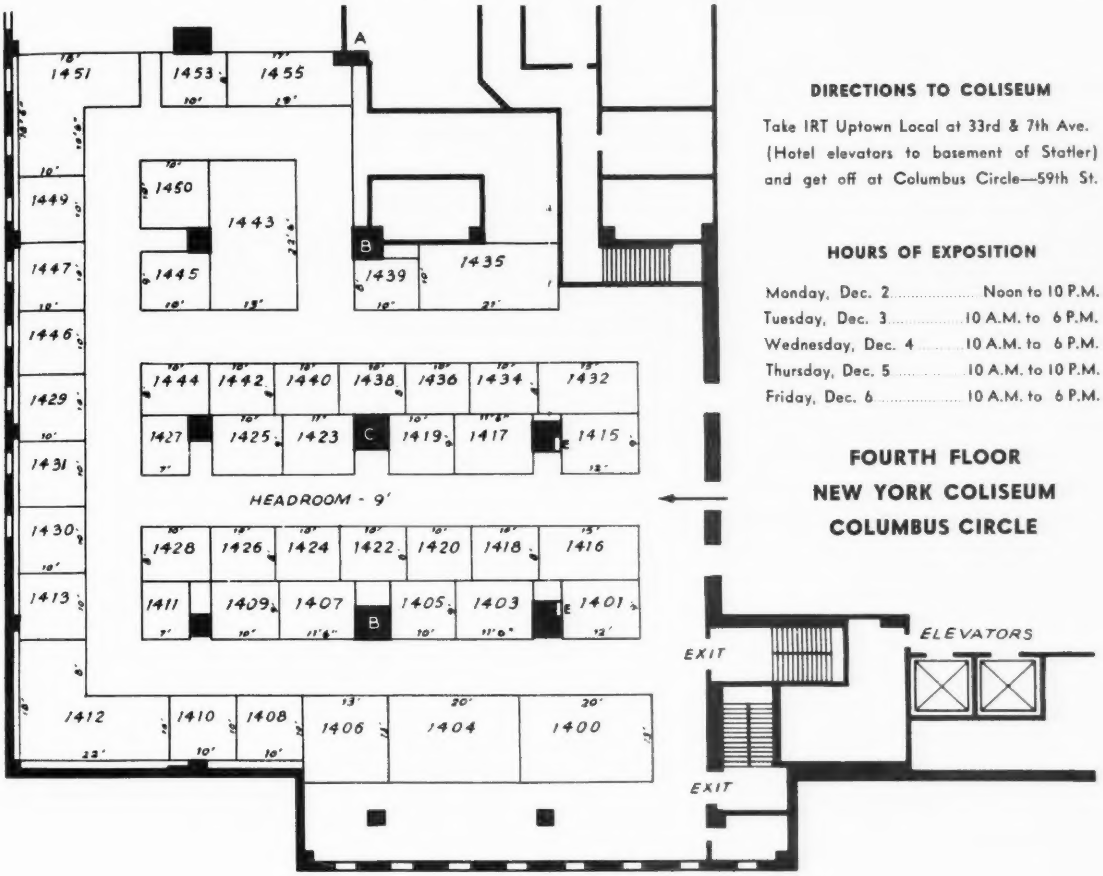
A noteworthy first for an ARS national meeting is the classified survey of the state of the art in liquid rocket propellants and combustion. The idea was conceived by P & C Chairman Tormey, and made possible by James R. Patton, Saul Berman, F. C. Wiesner, Ensign Don Medler and others at the Office of Naval Research.

Another first—thanks for which go to Mario Cardullo and Professor T. Paul Torda of the Polytechnic Institute of Brooklyn Chapter—is the Eastern Regional Student Conference. Six very high quality papers are on the agenda for the morning session and Program Chairman Stehling is lining up a panel of IGY luminaries for an afternoon forum, with the students firing questions. At this writing efforts are under way to invite a Soviet scientist to sound off on Sputniks.

Chrysler Corp. (and this was not in the advance program) is sponsoring the luncheons for official student delegates and their professors at the Conference luncheon. Principal speaker Joseph Kaplan, chairman of USNC-IGY, will be making his first public appearance in New York since the Russian satellite success.

Registrants at the meeting will be able to make a quick subway hop up to the Coliseum for a walk-by of missile hardware, the first-stage Vanguard engine, a shock tunnel for hypersonic studies, a solar furnace and some full-scale research rocket models, to enumerate only a few of the items on display at the ARS Rocket and Satellite Exhibit which will be part of the 26th Exposition of Chemical Industries. (CONTINUED ON PAGE 76)

ARS ROCKET AND SATELLITE EXHIBIT—Dec. 2-6



DIRECTIONS TO COLISEUM

Take IRT Uptown Local at 33rd & 7th Ave. (Hotel elevators to basement of Statler) and get off at Columbus Circle—59th St.

HOURS OF EXPOSITION

Monday, Dec. 2	Noon to 10 P.M.
Tuesday, Dec. 3	10 A.M. to 6 P.M.
Wednesday, Dec. 4	10 A.M. to 6 P.M.
Thursday, Dec. 5	10 A.M. to 10 P.M.
Friday, Dec. 6	10 A.M. to 6 P.M.

FOURTH FLOOR
NEW YORK COLISEUM
COLUMBUS CIRCLE

PARTIAL LIST OF EXHIBITORS

COMPANY	BOOTH NO.
Alco Products, Inc.	1415
Allied Chemical & Dye Corp.	1439
American Rocket Society	1416
Arwood Precision Casting Corp.	1417
Atlantic Research Corp.	1424, 1426
Beckman & Whitley, Inc.	1446
Bendix Aviation Corp.	
Bendix Products Div., Missile Section	1438
Pioneer Central Div.	1440
Brooks & Perkins, Inc.	1455B
Cambridge Corp.	1443
Chrysler Corp.—Missile Operations	1423
The Dow Chemical Co.—Magnesium Dept.	1429
Finn Aeronautical Div., T. R. Finn & Co.	1450
Food Machinery & Chemical Corp.	
Becco Chemical Div.	1436
Westvaco Chlor-Alkali Div.	1434

COMPANY	BOOTH NO.
General Electric Co.	
Missile & Ordnance Systems Dept.	1431
Rocket Engine Section	1430
Specialty Heating Products	1413
C. B. Kaupp	1425, 1427
Marman Div., Aeroquip Corp.	1419
The Martin Co.	1420, 1422
North American Aviation, Inc.—Rocketdyne Div.	1447, 1449
Phillips Petroleum Co.—Rocket Fuels Div.	1451
Ramo-Wooldridge Corp.	1453
Reaction Motors, Inc.	1435
Surprenant Mfg. Co.	1428
Thiokol Chemical Corp.	1442, 1444
H. I. Thompson Fiber Glass Co.	1445
Thompson Products, Inc., Jet Div.	1455A

15 outstanding technical sessions set

Among the subjects to be covered in papers are nuclear propulsion, dual-thrust solid rocket engines, solid fuel ramjets, space cabin development, inertial guidance, free radicals and ICBM telemetry

THE 15 technical sessions scheduled for the annual ARS meeting at the Hotel Statler Dec. 2–6 promise for the first time to reflect the full scope of AMERICAN ROCKET SOCIETY activities and interests.

Under the direction of Kurt Stehling, National Program Chairman, the seven ARS Technical Committees established earlier this year have done an outstanding job of combing the country's top rocket and guided missile centers for papers of unusual interest.

In recognition of the growing importance of electronics in the rocket and guided missile field, there will be two sessions on guidance and one on instrumentation at the meeting, as well as a special panel discussion on missile instrumentation.

The guidance sessions will include papers on infrared, beam rider guidance, electronic packaging for missiles and analyses of various phases of inertial guidance, while the instrumentation session will be highlighted by papers on such subjects as missile and ICBM telemetry and precision trajectory determination.

The solid rocket session also appears to be of unusual interest. Papers to be read include a discussion of the dual-thrust engine now under development at Aerojet and description of the miniature Atlantic Research rocket for use in spin and retro functions on the Vanguard vehicle.

Solid fuel ramjets, nuclear propulsion, free radicals, space cabin development, underwater propulsion, and navigation and communication techniques in interplanetary flight are among the many other provocative topics which will be discussed at other sessions.

A classified session surveying developments in liquid rocket propellants and combustion in 1957 promises to be another highlight of the meeting.

The full program, including ARS preprint numbers for all papers, follows:

ANNUAL MEETING PROGRAM

MONDAY, DECEMBER 2

2:00 p.m. **Penn Top—18th Floor**

Registration Opens

TUESDAY, DECEMBER 3

9:30 a.m. **Penn Top South**

Solid Rockets

Chairman: Dana McKinney, Allegany Ballistics Laboratory, Cumberland, Md.

Vice-Chairman: Arch Scurlock, Atlantic Research Corp., Alexandria, Va.

★ Temperature Profiles of Solid Propellant Charges During Combustion, by C. Theis, Rohm & Haas, Huntsville, Ala. (510–57)

★ A Miniature Solid Propellant Rocket, by J. N. Rossen, Atlantic Research Corp., Alexandria, Va. (511–57)

★ The Deacon Rocket, by L. E. Morey, Allegany Ballistics Laboratory, Cumberland, Md. (512–57)

★ The Dual-Thrust Solid Propellant Rocket Engine, by R. S. Newman, Aerojet-General Corp., Sacramento, Calif. (513-57)

9:30 a.m. **Penn Top North**

Combustion

Chairman: T. Paul Torda, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Vice-Chairman: R. S. Levine, Rocketdyne, Canoga Park, Calif.

★ Jet Mixing as a Combustion Tool, by J. J. Lovingham, Reaction Motors, Inc., Denville, N. J. (514–57)

★ Opposed Jet Flameholding, by A. E. Noreen and W. T. Martin, General Electric Co., Cincinnati, O. (515–57)

★ Effects of Stratified Fuel Distribution Upon Over-All Combustion Efficiency, by G. Warren Koffer and Gilbert S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif. (516–57)

★ Evidence for the Wrinkled Continuous Laminar Wave Concept of Turbulent Burning, by J. K. Richmond, W. F. Donaldson, J. Grumer, and D. S. Burgess, U. S. Department of the Interior, Bureau of Mines, Pittsburgh, Pa. (517-57)

★ Anomalous Extinction Phenomena in Solid Propellant Burning, by Donald L. Reid, Kimball P. Hall, and Martin Summerfield, Princeton University, Princeton, N. J. (518–57)

★ Ignition in a Boundary Layer Over a Hot Surface, by Tau-Yi Toong, J. Warren Davis, Karno Barkah, Edmund W. Sellman, John E. Snyder, and George F. Harper, Massachusetts Institute of Technology, Cambridge, Mass. (520–57)

2:30 p.m. **Penn Top North**

Ramjets

Chairman: Raymond Greenberg, Curtiss-Wright Corp., Wood-Ridge, N. J.

Vice-Chairman: Frank Tanczos, Bureau of Ordnance, Navy Department, Washington, D. C.

★ Fuels for Ramjets, by Walter G. Berl and W. T. Renich, Applied Physics Laboratory, Johns Hopkins Univ., Silver Spring, Md. (519–57)

★ A General Interpretation of One-Dimensional Flow Theory, by C. L. Dailey, Wiancko Aeronautics, a Division of Wiancko Engineering Co., Los Angeles, Calif. (521–57)

★ Solid Fuel Ramjets, by James W. Mullen II and Robert Wolf, Experiment, Incorporated, Richmond, Va. (522–57)

★ Calculation of Fluid Flow Through a Variable-Area "Can" Combustor, by

FEATURED SPEAKERS

Joseph Kaplan
Chairman, U. S. National Committee for the International Geophysical Year

Brig. Gen. H. F. Gregory
Commandant, Air Force Office of Scientific Research

William M. Holaday
Special Assistant to the Secretary of Defense for Guided Missiles

J. J. Zelinski, F. Falk, and E. C. Bagnall, Applied Physics Laboratory, Johns Hopkins Univ., Silver Spring, Md. (523–57)

2:30 p.m. **Penn Top South**

Propellants

Chairman: Irvin Glassman, Princeton Univ., Princeton, N. J.

Vice-Chairman: Charles H. King Jr., United Aircraft Corp., East Hartford, Conn.

★ Some Effects of Oxidizer Concentration and Particle Size on Resonant Burning of Composite Solid Propellants, by Leon Green, Aerojet-General Corp., Azusa, Calif. (524–57)

★ Free Radicals as High Energy Propellants, by G. C. Szego and E. A. Mickle, General Electric Co., Cincinnati, O. (525–57)

★ Improvement in the Operating Characteristics of N-Propyl Nitrate, by Robert W. Lawrence, Aerojet-General Corp., Azusa, Calif. (527–57)

★ Solid Propellant Requirements for Liquid Rocket Gas Pressurization, by Jerome Salzman, Reaction Motors, Inc., Denville, N. J. (528–57)

WEDNESDAY, DECEMBER 4

9:30 a.m. **Penn Top North**

Instrumentation

Chairman: King Stodola, Reeves Instrument Corp., Mineola, N. Y.

Vice-Chairman: Sidney Godet, Reeves Instrument Corp., Mineola, N. Y.

★ Recent Advances in Missile Telemetering, by Arthur Westneat, Applied Science Corp. of Princeton, Princeton, N. J. (561–57)

★ ICBM Telemetry, by Irving P. Magasiny, Tele-Dynamics, Inc., Philadelphia, Pa. (562–57)

★ A Precision Trajectory Determination System, by A. E. Cookson, Federal Telecommunication Laboratories, Nutley, N. J. (563–57)

★ The Utilization of the Sonic Thermodynamic Probe Under Transient Environmental Flow Conditions, by R. B. Edmonson, Aerojet-General Corp., Azusa, Calif. (564–57)

★ Design Problems Involved in a Free-Space Simulation Test Rig, by W. O. Borcherdt, Reaction Motors, Inc., Denville, N. J. (565–57)

9:30 a.m. **Penn Top South**

Space Law and Sociology

Chairman: William C. Boyd, Boston Univ., Boston, Mass.

Participants: William C. Boyd, Boston Univ., Boston, Mass.; Andrew G. Haley, Haley, Wollenberg & Kenehan, Washington, D. C.; Oscar Schachter, United Nations, New York, N. Y.; Donald N. Michael, Dunlap & Assocs., Inc., Stamford, Conn.

12:00 Noon

New York Section Luncheon

Presiding: Robert A. Gross, President, ARS New York Section, Fairchild Engine Div., Deer Park, N. Y.

Speaker: Brigadier General H. F. Gregory, USAF, Commander, Headquarters, Air Force Office of Scientific Research, Air Research and Development Command, Washington, D. C.

Topic: Exploratory Research

2:30 p.m. **Penn Top North**

Liquid Rockets

Chairman: H. B. Ellis, Aerojet-General Corp., Azusa, Calif.

Vice-Chairman: C. M. Beighley, Aerojet-General Corp., Sacramento, Calif.

★ Analysis of Combustion Instability and of Scaling-Up of Liquid Propellant Rocket Motors and Other Combustion Chambers, by T. Paul Torda, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (556–57)

★ The Effect of Fuel Additives on Combustion Instability, by C. H. Trent, Aerojet-General Corp., Azusa, Azusa, Calif. (557–57)

★ Flight Environmental Effects on Rocket Engine System Performance, by R. Loveland, Reaction Motors, Inc., Denville, N. J. (558–57)

★ Rocket Propulsion with Nuclear Energy, by M. Rosenblum, W. Rinehardt, T. Thompson, Rocketdyne, Canoga Calif. (559–57)

★ Chamber Pressure Control for a Liquid Rocket Engine, by Louis deBottari, Servomechanisms, Inc., Hawthorne, Calif. (546–57)

★ Variational Solution of Fuel Sloshing Modes in a Circular Tank with Variable Depth, by H. R. Lawrence, C. J. Wang, and R. B. Reddy, Ramo-Wooldridge Corp., Los Angeles, Calif.

2:30 p.m. **Penn Top South**

Human Factors

Chairman: Hubertus Strughold, School of Aviation Medicine, Randolph Air Force Base, Tex.

Vice-Chairman: John P. Stapp, Aero

NEW FELLOW MEMBERS

Lt. Col. Langdon F. Ayres
AF Ballistic Missile Div.

Maj. Gen. John B. Medaris
Army Ballistic Missile Agency

Maj. David G. Simons
Aero Medical Field Laboratory

Medical Field Laboratory, Holloman Air Force Base, N. M.

★ Calculations on a Manned Nuclear-Propelled Rocket Space Vehicle, by Krafft A. Ehricke and Coleman Whitlock, Convair-Astronautics, San Diego, Calif. (532–57)

★ Human Factors and Space Cabin Development, by Eugene B. Konecci, Douglas Aircraft Co., Inc., Tulsa, Okla. (533–57)

★ Certain Fundamental Approaches to the Use of Biological Material in Space Devices, by Irwin Cooper, Rand Corp., Santa Monica, Calif. (534–57)

★ Photo-Ecological Environment of Space, by Hubertus Strughold, School of Aviation Medicine, Randolph Air Force Base, Tex. (535–57)

★ Observations Made during Manhigh II Flight, by David G. Simons, Aero Medical Field Laboratory, Holloman Air Force Base, N. M. (536–57)

★ Operation Manhigh II, by Otto C. Winzen, Winzen Research, Inc., Minneapolis, Minn., and Druey P. Parks, Aero Medical Field Laboratory, Holloman Air Force Base, N. M. (537–57)

★ Sensory Reactions Related to Weightlessness and Their Implications to Space Flight, by Grover J. D. Schack, Holloman Air Force Base, N. M. (538–57)

★ Approach to the Problem of Space Flight Experimentation, by George Hoover, Office of Naval Research, Washington, D. C. (539–57)

★ Space Flight in the Undersea, by C. C. Brock, Office of Naval Research, Washington, D. C. (540–57)

★ The Environmental Problem of Space Flight, by Loyal Goff, Office of Naval Research, Washington, D. C. (541–57)

4:30 p.m. **Penn Top North**

Annual Business Meeting

Presiding: Robert C. Truax, President ARS

8:00 p.m. **Sky Top Room**

New York Section Film Night

Presiding: Robert A. Gross, President, New York Section, ARS. Films to be shown include: *A Moon Is Born, Vanguard films, Road to the Stars, Honest John, The Corporal Story,* and *Solid Propellant Rocketry.*

THURSDAY, DECEMBER 5

9:30 a.m. **Penn Top South**

Space Flight

Chairman: Grayson Merrill, Fairchild Guided Missiles Division, Wyandanch, L. I.

Vice-Chairman: George Colchagoff, Air Research & Development Command, Baltimore, Md.

★ Optimum Rocket Trajectories with Aerodynamic Drag, by A. E. Bryson Jr. and Stanley E. Ross, Harvard University, Cambridge, Mass. (542–57)

★ Generalized Trajectories for Free Falling Bodies of High Drag, by R. E. Turnacliff and J. P. Hartnett, University of Minnesota, Minneapolis, Minn. (543–57)

★ On Catalytic Recombination Rates in Hypersonic Stagnation Heat Transfer, by Robert Goulard, Purdue Univ., Lafayette, Ind. (544–57)

★ Navigation and Communication Techniques in Interplanetary Travel, by Peter A. Castruccio, Westinghouse Air Arm Division, Baltimore, Md. (545–57)

9:30 a.m. **Penn Top North**

Guidance (1)

Chairman: William C. Strang, Convair, Pomona, Calif.

Vice-Chairman: Abe Bernstein, Philco Corp., Philadelphia, Pa.

★ Infrared Today, by Donald Wahl, Avion Division, ACF Industries, Inc., Paramus, N. J. (547–57)

★ Oblateness Correction to Impact Point of a Ballistic Missile, by R. E. Roberson, Autonetics, Div. of North American Aviation, Inc., Downey, Calif. (548–57)

★ Selection of an Aerodynamic Configuration for Improved Beam Rider Guidance, by Basil Staros, Richard W. Gretz and Merven W. Mandel, Air Armament Division, Sperry Gyroscope Co., Division of Sperry Rand Corp., Great Neck, N. Y. (549–57)

★ A Feasibility Study for Minimum Weight Radio Instrumentation of a Satellite, by Henry L. Richter and Robertson Stevens, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif., and William F. Sampson, Hallamore Electronics Co., Anaheim, Calif. (550–57)

★ Use of Coherent Phase Detection in Guidance and Instrumentation Systems, by C. L. Nielsen, Hallamore Electronics Co., Anaheim, Calif. (555–57)

12:00 Noon

Section Delegates' Luncheon

Presiding: Robert C. Truax, President ARS, Summary of 1957 Activities of the ARS Sections.

2:00 p.m. **Sky Top Room**

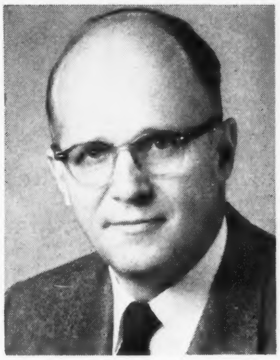
Classified Survey of Liquid Rocket Propellants and Combustion in 1957 (CONFIDENTIAL)

Co-Chairman: Adelbert O. Tischler, Lewis Flight Propulsion Laboratory, NACA, Cleveland, O.

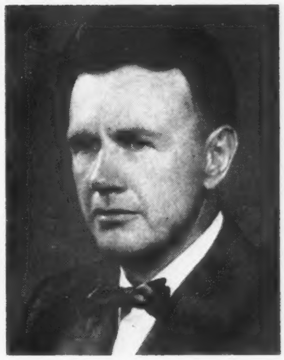
Co-Chairman: David Altman, Aeronutronic Systems, Inc., Glendale, Calif.

★ Survey Paper on Liquid Rocket Combustion, by Adelbert O. Tischler, Lewis Flight Propulsion Laboratory, NACA, Cleveland, O.

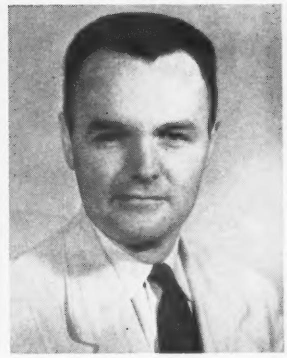
S. Fred Singer
University of Maryland



Noah S. Davis
Food Machinery & Chemical Corp.



Henry L. Thackwell Jr.
Grand Central Rocket Co.



John F. Tormey
Rocketdyne

★Comments on previous paper by: Herbert B. Ellis, Aerojet-General Corp., Azusa, Calif.; Robert S. Levine, Rocketdyne, Canoga Park, Calif.; Kurt Berman, General Electric Co., Malta Test Station, Ballston Spa, N. Y.; Jerry Grey, James Forrestal Research Center, Princeton Univ., Princeton, N. J.; Robertson Youngquist, Reaction Motors, Inc., Denville, N. J.

★Survey Paper on Liquid Rocket Propellants, by David Altman, Aeronutronic Systems, Inc., Glendale, Calif.

★Commentaries on above paper by: Paul F. Winternitz, New York Univ., New York, N. Y.; John Sloop, Lewis Flight Propulsion Laboratory, NACA, Cleveland, O.; Robert J. Thompson Jr., Rocketdyne, Canoga Park, Calif.; Don L. Armstrong, Aerojet-General Corp., Azusa, Calif.; Thomas F. Reinhardt, Bell Aircraft Corp., Buffalo, N. Y.

2:30 p.m. **Penn Top North**

Guidance (II)

Chairman: Walter Wrigley, Massachusetts Institute of Technology, Cambridge, Mass.

Vice-Chairman: Ben Alexander, Federal Telecommunication Laboratories, Nutley, N. J.

★Servo Considerations in an Inertially Stabilized Reference System Utilizing Air-Bearing Gyros, by Lewis J. Scheuer and John P. Jagy, Ford Instrument Co., Div. of Sperry Rand Corp., Long Island City, N. Y. (551–57)

★Aided Inertial Systems, by C. J. Mundo and M. G. Hullabaugh, Arma Div., American Bosch Arma Corp., Mineola, N. Y. (552–57)

★Analysis of an Inertial Guidance System, by D. B. Duncan, Autonetics Div., North American Aviation, Inc., Downey, Calif. (553–57)

★Electronic Packaging in the Terrier Missile, by Henry E. Chrystie, Convair, Pomona, Calif. (554–57)

2:30 p.m.

Section Delegates' Conference

Presiding: John P. Stapp, Chairman, Membership Committee

7:00 p.m. **Main Ballroom**

Honors Night Dinner

Presiding: Robert C. Truax, President, American Rocket Society

Speaker: William M. Holaday, Special Assistant to the Secretary of Defense for Guided Missiles

FRIDAY, DECEMBER 6

9:30 a.m. **Penn Top North**

Guided Missile Instrumentation Panel

Chairman: Robert W. Luke, Ramo-Wooldridge Corp., Los Angeles, Calif.

Panel Members: R. J. Horak, Marquardt Aircraft Co., Van Nuys, Calif.; George Barr, Ramo-Wooldridge Corp., Los Angeles, Calif.; John P. Day, Kin Tel, San Diego, Calif.; Max A. Lowy, Ramo-Wooldridge Corp., Los Angeles, Calif.

EASTERN REGIONAL STUDENT CONFERENCE

Under auspices of Polytechnic Institute of Brooklyn Chapter.

Entire day's program is open to students and all ARS members.

9:30 a.m. **Penn Top South**

Student Paper Presentations

Chairman: Mario Cardullo, Polytechnic Institute of Brooklyn, Brooklyn, New York.

★The "Strong" Balloon Telescope, by Ronald M. Strake, Johns Hopkins Univ., Baltimore, Md.

★Overexpanding Nozzles in Rocket Motors, by Michel E. Maes, Univ. of Washington, Seattle, Wash.

★An Application of Particle Dynamics to the Measurement of Rocket Exhaust Velocity, by John Reece Roth, Massachusetts Institute of Technology, Cambridge, Mass.

★Analysis and Design of a Small Liquid Propellant Engine System, by W. T. Peschke, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

★An Automatic Chamber Pressure and Mixture Ratio Control System for Liquid Propellant Rocket Motors, by F. H. Reardon, Princeton Univ., Princeton, N. J.

★Inertial Guidance, by F. Schuyler, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

12:00 Noon **Sky Top Room**

Luncheon

Chairman: Charles W. Williams, Chrysler Corp., Missile Operations, Detroit, Mich.

Speaker: Joseph Kaplan, Chairman, U. S. National Committee for the International Geophysical Year

2:30 p.m. **Penn Top South**

IGY Forum

Presiding: Kurt Stehling, Chairman, Program Committee, ARS, Project Vanguard, Naval Research Laboratory, Washington, D. C.

A panel of scientists and engineers involved in IGY will discuss and answer questions on: U. S. and Russian earth satellites; high altitude research rocket firings; IGY experiments in meteorology, solar activity, airglow, aurora, ionospheric physics, geomagnetism and cosmic rays.

Filling the gap

Among the projects now under way at the AF Cambridge Research Center are two new high-altitude sounding rockets, three different 1000-lb satellites, and a monatomic ramjet taking fuel from the atmosphere

By Michael L. Yaffee

MANAGING EDITOR OF ASTRONAUTICS

BEDFORD, MASS.—Overlooked in all the excitement engendered by Sputnik's sudden success and Project Farside's first failures have been some solid and rather spectacular projects under way here at the Air Force Cambridge Research Center. Items: Two new high-altitude sounding rocket systems, three different 1000-lb satellites, and a monatomic ramjet that will take its fuel from the atmosphere.

As now planned, the new sounding rockets will be the first of the projects actually to take to the air. Taking over where present systems leave off, they will cover the region from 300 to 1000 miles up. Firings are scheduled to begin sometime during May, 1958 (see schedule on facing page), thus overlapping the present AF rocket program, which calls for 74 firings of Nike-Cajuns and Aerobee-Hi's from August, 1957 to November, 1958.

True to the philosophy of the Center's Special Projects Laboratory, the new rockets will be derived from existing missile systems and off-the-shelf hardware. Exos, the smaller of the two, is a follow-up on the Nike-Cajun, and was so named because it will carry to the lower reaches of the exosphere. Tentative SPL plans call for an altitude range of 300 to 450 miles with a 50-lb payload.

Exos will be a three-stage solid propellant rocket. First stage will be an Honest John; second stage, a Nike booster; and third stage, a Recruit. NACA, University of Michigan and M.I.T. worked with AFCRC on various phases of the development program. And the University of Michigan Aeronautical Center now has the AF contract to produce the system.

Will Use Available Hardware

Cost of the Exos is expected to be about $17,000. By using available hardware, one SPL engineer points out, "we can give the scientists a research vehicle with twice the altitude of an Aerobee-Hi for about half the firing cost, and it's a lot faster

MISSILE MASTERS: This is the staff of the Special Projects Laboratory, the group that is responsible for providing AFCRC with research rockets and satellites. From left: Robert Slavin, Louis Kraff Jr., Charles Reynolds and Lab Chief Elbert Eaton.

U. S. Air Force Rocket Research Program . . .

VEHICLE	FIRINGS Aug. '57–Nov. '58	May–Dec. '58	Jan.–Dec. '59	Jan.–Dec. '60	Dec. '62
Aerobee-Hi Nike-Cajun (100–190 miles)	74				
Exos (300–450 miles)		16	24	24	
Unnamed Rocket (300–1000 miles)		14	22+	29+	
Verifier Vehicles					
(1 Earth Radius)			2+	2+	
(? Earth Radii)			1	2+	
Satellites					?

. . . and Some Unknown Areas To Be Probed

	Earth	Earth's Atm.	Solar Influence	Solar Physics	Local Space	Astral Influence	Astro-physics	Moon, Planets
Aerobee-Hi Nike-Cajun		X	X		X			
Exosphere Rockets					X			
Verifier Rockets	X	X	X	X	X			
Geophysical Satellite	X	X	X		X			
Solar Satellite			X	X	X			
Astral Platform					X	X	X	X

than trying to develop a new vehicle." The choice of a solid system, he adds, was dictated by the numerous significant advances in this area recently, coupled with the solid's characteristic logistic simplicity and inexpensiveness.

The second and larger sounding rocket system, still unnamed, is slated to operate in the 300-to-1000-mile altitude range. Like Exos, it will probably be a staged solid propellant system, and is expected to be airborne about March, 1958. Payload and hardware have not yet been specified. Undoubtedly, AFCRC engineers will base the vehicle on an existing missile system, perhaps an Air Force IRBM or ICBM.

By far the most ambitious of the AFCRC projects are three different types of satellites, each to carry a 1000-lb payload in orbits at least 4000 miles out from the earth. Also an outgrowth of the present Air Force upper-air research program, the satellites will not go into the air until some time after the current rocket program ends.

Present plans, now under consideration at ARDC headquarters in Baltimore, call for a geophysical satellite "to study the earth, its atmosphere and the space in which the vehicle is moving;" a solar physics satellite "to study solar behavior and the solar radiations that influence space and planetary atmospheres;" and an astral platform "to study the cosmic radiations entering our solar system and to study the nearer planets and the moon."

Orbits tentatively selected for the satellites are one earth radius (4000 miles) and multiples thereof. Scientists at AFCRC declare that Sputnik and Vanguard move too (CONTINUED ON PAGE 72)

Dog in space

Firing of 1120-lb Sputnik II satellite removes last vestiges of doubt regarding Soviet achievements in rocket and space flight

By Irwin Hersey

EDITOR OF ASTRONAUTICS

WHILE dog lovers throughout the world were up in arms over the fact that Sputnik II was carrying a Siberian husky on its flights around the earth, scientists both in this country and abroad were unanimous in hailing the second successful Soviet satellite launching in less than a month as a major scientific achievement.

Since the Russians had, in the weeks preceding the firing of the second Sputnik (immediately dubbed "Muttnik" by the American press), introduced the dog slated to be the first space traveler on a Moscow Radio broadcast and had repeatedly asserted that preparations for launching the satellite were nearing completion, announcement of the successful launching Nov. 3 was not the surprise that Sputnik I had been.

Nevertheless, it had tremendous impact in that it did away once and for all with any lingering doubts about Soviet accomplishments in the fields of rocketry, guided missiles and space flight, and convinced even those skeptics who had maintained that the launching of Sputnik I was just a lucky shot.

The failure of the Russians to reveal any details about the launching vehicle led to immediate speculation that a different and even larger rocket, perhaps using high energy fuels, had been used to launch Sputnik II, with its 1120-lb payload. However, a careful examination of the first Soviet announcements regarding the feat, and a consideration of previous comments by Red rocket experts regarding Sputnik I, indicate that the same type of launching vehicle may have been used on both occasions.

As Martin Summerfield notes in his article on page 34, use of the Red IRBM as the first stage of the launching vehicle, and other currently available military hardware for the second and third stages, would permit launching of a payload weighing 500 lb. This is in line with a statement by A. A. Blagonravov, a top Soviet rocketry expert, at the time of the Sputnik I launching, that the vehicle could be used to fire a satellite "two or three times again as large" as the first one.

Information Lacking in Details

Speculation over the vehicle used to fire Sputnik II arose over vagueness in early Russian announcements, which noted that the satellite was actually the last stage of the carrier rocket, and included containers with scientific instruments, as well as radio transmitters. The weight given was 1120 lb, but the announcement did not make clear whether or not this 1120 lb included the weight of the rocket shell.

If it did, the same vehicle used to launch Sputnik I might have been used to launch Sputnik II with

only a slight increase in thrust, perhaps of the order of 25 per cent. Adding the 500-lb satellite which could theoretically be placed in orbit by the Sputnik I launcher to an estimated weight of at least 300 lb for the empty shell of the third-stage rocket would give a total weight of 800 lb or more, compared to a total weight of 1120 lb for Sputnik II satellite and its rocket shell—if the weight of the rocket shell is included in the weight figure given.

If, however, that 1120-lb figure is over and above the weight of the empty third-stage rocket shell—a possibility in view of the instrumentation the satellite carried—a different vehicle might well have been used.

In this event, the Red ICBM engine, with thrust estimated by various sources to range from 500,000 to 1,000,000 lb, could have been used for the first stage. However, it is regarded as more likely that the Reds once again resorted to use of their proved IRBM engine, with somewhere from 250,000 to 275,000 lb of thrust. One possibility in this case might be the use of twin IRBM's in tandem in the first stage, with other off-the-shelf military hardware, producing more thrust than was required for Sputnik I, used for the second and third stages. A third possibility, but less likely because of the increased complexity, is that a fourth stage was added to the three-stage vehicle used to fire the first satellite.

Despite Russian hints of "new power sources," it is regarded as unlikely that high energy fuels and/or free radicals were employed. The general impression is that in both firings a kerosene-LOX combination was used, at least for the first and second stages.

In this instance again, guesses as to what these new power sources might have been are purely speculative. That some form of nuclear propulsion was used is regarded as highly unlikely. Best bet would be an advanced chemical propellant, probably based on boron or lithium. Another, but less likely, possibility would be monatomic hydrogen.

Overshadowing even the propulsion and fuel aspects of the feat, however, are the implications of the Sputnik II launching. Obviously the Russians are capable of putting large payloads into orbit, and perhaps even capable of putting a payload on the moon. Just what these vehicles are we will learn when the Russians are prepared to tell us about them.

There was a tendency when Sputnik I was fired to regard its instrumentation as unsophisticated, compared to the instrumentation planned for Vanguard. Even this small solace has been denied us in the successful launching of Sputnik II.

The Russians say the second satellite carries instruments for recording solar radiation in the shortwave, ultraviolet and X-ray regions of the spectrum; for making cosmic ray studies; and for measuring temperature and pressure. It also has two radio transmitters, operating at 20 and 40 mc, and the power sources necessary for operating all instruments.

All this is over and above the equipment necessary for keeping an animal alive in space. This means an air-tight capsule, air conditioning equipment, and a food and water supply, plus instrumentation for studying the dog while it is in the capsule.

Perhaps most significant is the fact that the Russians feel there is a possibility of bringing the dog safely back to earth. If they succeed in so doing, they will have accomplished a feat of major magnitude, and one with great implications.

Aside from the data which the satellite can accumulate at very high (CONTINUED ON PAGE 84)

SPUTNIKS COMPARED

	Sputnik I	Sputnik II
Date of launching	Oct. 4	Nov. 3
Shape	Round	Conical
Size	23 in. diam	50 ft long (?)
Weight	184 lb	1120.29 lb
Altitude at apogee	560 miles	1056 miles
Speed	18,000 mph	17,840 mph
Orbital period	96.2 min	103.7 min
Angle to equator	65 deg N to S	65 deg, no direction given
Signal	Radio beep at 0.3 sec intervals on 20 and 40 mc; now silent	Radio beep at 0.3 sec intervals on 20 mc; continuous tone on 40 mc.

How orbits of Sputniks I and II compare. Their paths, according to radio monitoring, are displaced from each other by about one-third of the earth's girth.

Sputnik and Vanguard: A comparison

An educated guess as to what the first Soviet launching vehicle was like, along with an analysis of the different approaches used by Russia and this country in constructing their orbital carriers

By H. H. Koelle

ARMY BALLISTIC MISSILE AGENCY, HUNTSVILLE, ALA.

A PROPHETIC PAPER

It's doubtful if even Heinz H. Koelle, chief of the ABMA Preliminary Design Section, realized when he was writing his paper on "Optimum Considerations for Orbital Payload Capacities" (ARS Preprint No. 491–57), presented at the Eighth International Astronautical Congress in Barcelona, that it would be as timely as it turned out to be.

The paper, which contains a careful comparison of the U. S. and Soviet approaches to the problem of building an orbital carrier, also includes what may well be one of the most educated guesses as to what the Russian satellite launching vehicle was actually like, and a possible explanation of how such a heavy payload was placed in orbit.

In one instance, at least, Koelle proved prophetic. After noting that whoever did manage to establish a satellite in orbit first would be honored by history as being the first to accomplish a breakthrough which would benefit the entire human race, he added a parenthetical aside that went as follows:

"The answer to this question was not available at the time this paper was written but it might be available by the time it is presented."

The Sputnik launching, just a few days before the paper was actually presented, made the parenthetical note academic.

Here, for the first time, is the complete text of that portion of the Koelle paper dealing with this subject.

OUR PRESENT wishes and needs for artificial satellites with a large payload of scientific instruments are, and always will be, limited by the orbital payload capacity of available carriers.

One way of doing the job is by using existing hardware which becomes available in the course of military development of long-range missiles. This is a very convenient, logical and economical way, because military necessity has sponsored the development of rocket components which can be used also for orbital carriers and space vehicles.

One typical example of using components from military developments is the Russian design which is reported in newspapers occasionally. It would be logical to assume that the Russians are using the powerful 264,000-lb thrust booster of their intermediate range ballistic missile as the basic booster of their three-stage orbital carrier, and the improved 77,000-lb thrust V-2 missile as the second stage. The development of this combination goes back as far as 1948.

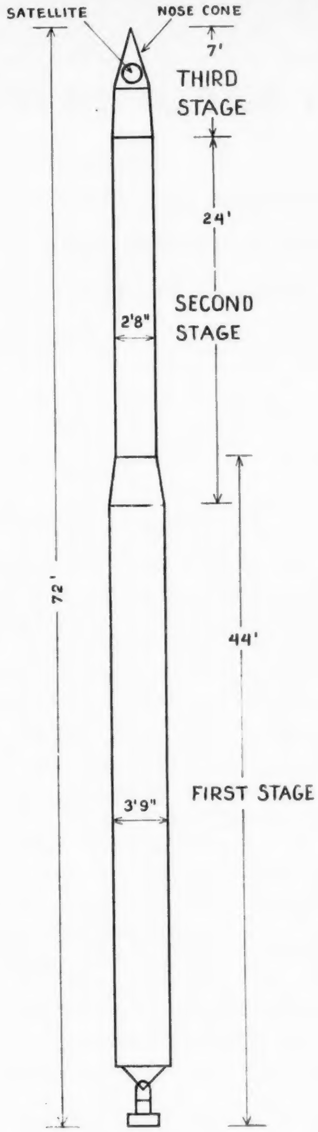
Has Advantage of Using Proven Hardware

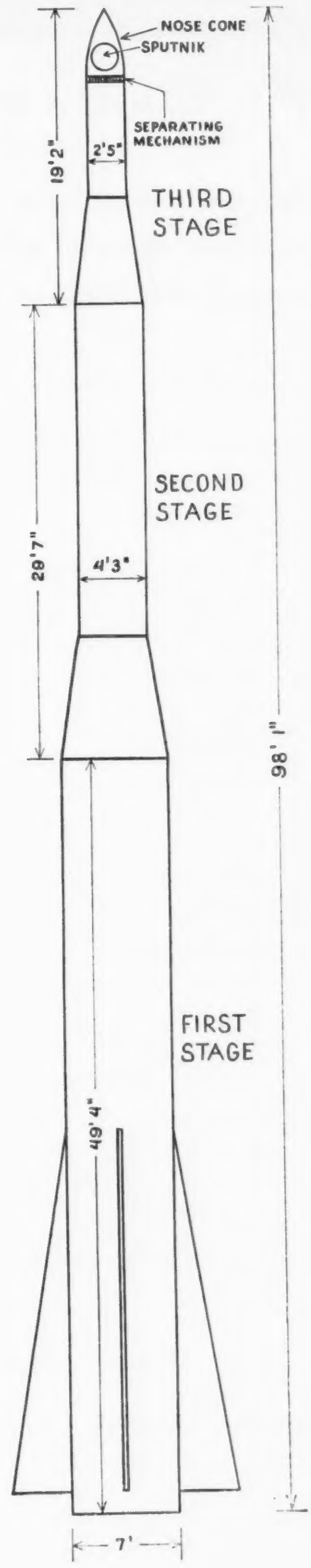
This approach is very attractive because it has the advantage of using proven hardware with established reliability. It also promises a schedule which seems to be realistic. The job remaining to be done is to develop a third stage and to mate it properly with the other two stages. Even for this third stage, proven hardware seems to be in stock, since the improved Wasserfall engine with about 20,000-lb. thrust, under development for almost a decade, might be a proper choice.

Disadvantages of this solution are three different propellant combinations for the missile, the limited specific impulse in the upper stages, and perhaps a total structural factor (ratio of hardware-weight over take-off weight) which is not representative of the present state of the art. This will probably result in a growth factor (ratio of take-off weight over payload weight) which will be somewhat larger than that of an optimized missile of similar size designed by standards of the present stage of the art.

Nevertheless, this three-stage configuration will offer up to several hundred pounds orbital payload capability, which is at least 10 times as much as the first American orbital (CONTINUED ON PAGE 80)

How Vanguard and Sputnik I Launching Vehicles Shape Up





	VANGUARD	SPUTNIK I
First Stage	28,000 lb thrust	264,000 lb thrust (IRBM booster)
Second Stage	7500–8000 lb thrust	77,000 lb thrust (improved V-2)
Third Stage	2800 lb thrust	20,000 lb thrust (improved Wasserfall)

NOTE: All Sputnik dimensions are estimated. Artist's conception of Sputnik vehicle is based on assumption currently available Soviet military hardware was used. With alcohol-LOX combination in all three stages, gross weight of vehicle is calculated as 150,000 lb, including 30,000 lb for second stage and 5000 lb for third stage. Dimensions were calculated using average density of Viking No. 11, increased 20 per cent to allow for recent improvements.

ASTRONAUTICS Report—Part Two

Problems of launching an earth satellite

This analysis of flight performance, multi-stage techniques and firing programs offers an indication as to design of Sputnik I launcher and suggests the vehicle is capable of putting a 50-lb payload on the moon

By Martin Summerfield

TECHNICAL EDITOR, ASTRONAUTICS
PROFESSOR OF JET PROPULSION, PRINCETON UNIVERSITY

LAST month we examined the characteristics of various types of earth-circling orbits and calculated the energy required to place an object in an orbit at any specified altitude. We considered also the extra energy needed as a margin of safety to overcome errors either in cut-off velocity or in angle of injection at orbit altitude. Finally, it was indicated that some extra launching energy would also be needed to ascend to orbit altitude by a steep path instead of by the minimum energy, tangent ellipse, a much less practical path.

An effective launching velocity V_L was introduced as a measure of the required launching energy for an orbit *c*: $E_c = {}^1/_2\, V_L^2$. The result of all these energy considerations is that required V_L for a close-in orbit is about 29,000 ft/sec, and perhaps 1000 ft/sec less if a slingshot contribution of that magnitude can be obtained from the earth's rotation.

Now we shall examine the flight performance of a single-stage rocket, and we will find it is practically impossible to achieve an effective launching velocity of 29,000 ft/sec by such means. The solution, of course, lies in the principle of multi-staging.

In the illustration on the facing page, a rocket is pictured in vertical flight in the earth's gravitational field. Under certain simplifying assumptions that can be shown to be justifiable (negligible drag, constant gravitational g, constant specific impulse), the differential equation of motion can be integrated once to obtain the burnout velocity V_{BO}. It is possible to insert in the resulting formula various values of specific impulse I_{sp}, dead-weight fraction *s*, payload fraction *l*, and thrust/full weight ratio *r*, and thereby calculate the burnout velocity for a rocket rising vertically from rest or from any initial velocity V_0. Calculated burnout velocities are plotted in the illustration on the bottom of page 35 on the basis of this equation.

In this discussion, V_{BO} is compared directly with the required V_L to determine the practicality of a particular rocket design as a satellite launcher. In so doing, the potential energy gained by the rocket during the power-on phase is neglected. It can be shown that this potential energy is only a small part of the total, and it simplifies the discussion to neglect it.

The table shown below lists the calculated burnout velocities for four hypothetical single-stage rockets, computed according to the formula shown. Case 1 is a rocket similar to the V-2; Case 2 is an improvement over the V-2 in that the dead-weight fraction is reduced and specific impulse raised; Case

BURNOUT VELOCITIES OF SEVERAL HYPOTHETICAL SINGLE-STAGE ROCKETS

Case No.	Propellant	Avg. I_{SP}(sec)	*s*	*l*	*r*	m_{prop}/m_{full}	*tp*(sec)	V_{BO}(fps)
1	Oxy-alcohol	220	0.20	0.10	2.0	0.70	77	6,070
2	Oxy-gasoline	260	0.10	0.05	2.0	0.85	110	12,360
3	Oxy-gasoline	260	0.10	0.05	1.5	0.85	147	11,160
4	Hydro-fluor	350	0.08	0.02	2.0	0.90	158	20,900

THEORY OF ROCKET FLIGHT PERFORMANCE

Acceleration with power on (drag negligible, constant g):

$$M \frac{dV}{dt} = F - Mg$$

Rocket thrust equation:

$$F = -gI_{sp} \cdot \frac{dM}{dt}$$

Substitute for F and integrate:

$$V_{BO} - V_o = gI_{sp} \ln \left(M_{\text{full}} / M_{\text{empty}} \right) - gt_{\text{power}}$$

The duration of powered flight (constant thrust case):

$$t_{\text{power}} = \frac{(M_{\text{full}} - M_{\text{empty}})gI_{sp}}{F}$$

Define dead-weight fraction s and payload fraction l:

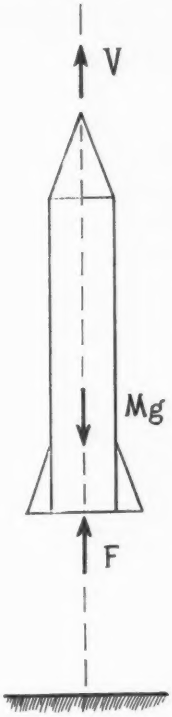
$$M_{\text{empty}} = M_{\text{full}} (s + l)$$

Define thrust-to-full-weight ratio r:

$$F = M_{\text{full}}\, gr$$

Substitute s, l, r in formula for V_{BO}:

$$V_{BO} - V_o = gI_{sp} \left[\ln \left(\frac{1}{s + l} \right) - \frac{(1 - s - l)}{r} \right]$$

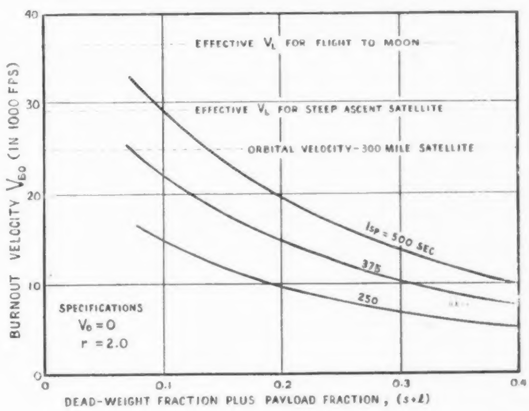


3 is a rocket similar to that of Case 2, but with a smaller thrust-weight ratio; Case 4 is the ultimate with chemical propellants—hydrogen-fluorine—in a very lightweight structure.

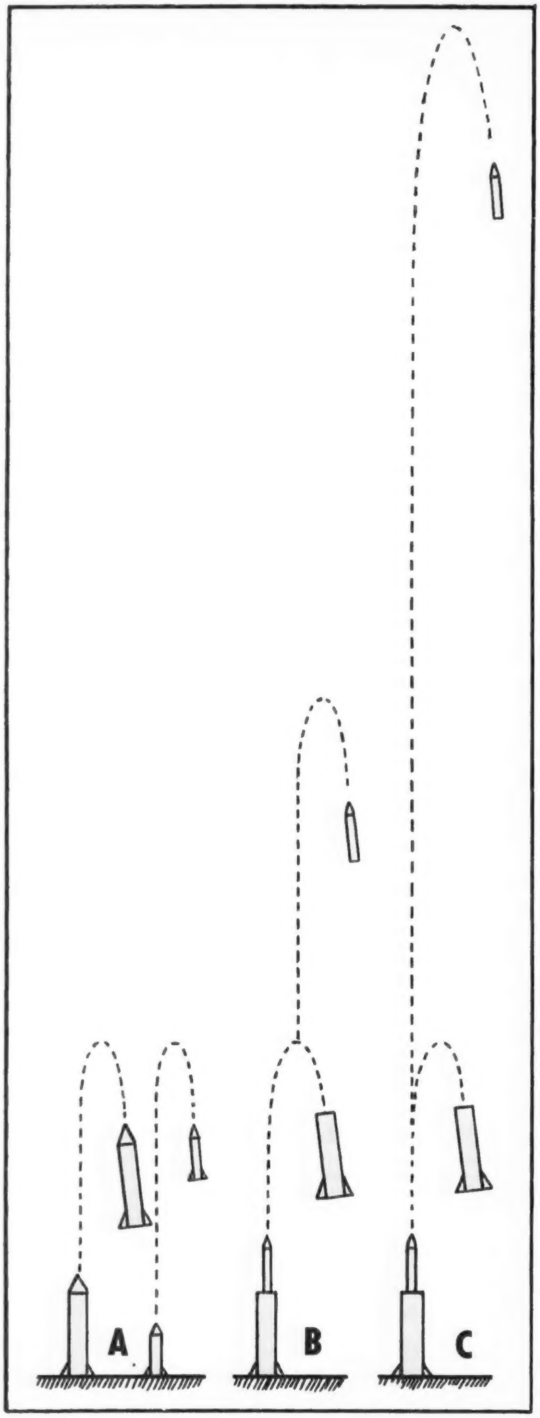
Consideration of these results leads to several conclusions. First, the attainment of launching speed sufficient for a close-in circular orbit is practically impossible with a single-stage rocket, even if the most energetic chemical propellant and the very lightest of structures are used. Of course, there is always the possibility of developing a novel and more energetic propellant, such as a concentrated free-radical mixture or one based on a nuclear reaction, and there is no absolute minimum (other than zero) for the dead-weight fraction, and therefore we must concede the possibility of developing a single-stage satellite launcher some time in the future. But we shall restrict ourselves here to present-day practical propellants and practical dead-weight fractions.

A second conclusion is that it is very important to minimize the dead-weight fraction by efficient structural design. This means, for example, the abandonment of the factor-of-safety philosophy of ordinary design practice. Usually, a factor of safety is an ignorance factor and is imposed on the design to cover up uncertainty as to local or instantaneous stress concentrations, possible defects in manufacture or gradual deterioration of the structure. The penalty of such an approach is excessive weight.

PERFORMANCE OF SINGLE-STAGE ROCKET



PRINCIPLE OF MULTI-STAGING



A. Two equivalent rockets. Each reaches same altitude.
B. Small rocket fired at *summit* of first stage.
C. Small rocket fired at *burnout* of first stage.

This can be avoided only by careful design backed by structural research and close control of manufacturing processes.

A point of interest is that the size of the rocket is not very important in achieving a desired burnout velocity, provided the payload and structural weights are maintained in the same proportion to the gross weight of the rocket. The final equation on page 35 contains neither the thrust nor the weight of the rocket. As a practical matter, however, it is difficult to design a small rocket with the same low dead-weight fraction as a large one. In addition, to avoid the relatively greater drag effect, the small rocket has to be launched above the atmosphere, for example, from a balloon.

Single-Stage Rocket Optimization

It is obvious that, even for a single-stage rocket, there is a complicated optimization problem in choice of propellant, of thrust-weight ratio and of slenderness ratio. From the burnout velocity equation, it can be seen that a large value of r is advantageous, but the advantage may be severely reduced or even reversed if the increased powerplant weight and the high acceleration that result from large r should require a strong increase in the value of s. It can also be seen that a large value of I_{sp} is desirable, but if it involves a low-density propellant such as liquid hydrogen, the gain might be reduced or destroyed by the resulting increase in s.

It is not our intention to analyze this optimization problem in detail in this article. For our purpose, it is sufficient to say that a sea-level specific impulse of about 250 sec and a dead-weight fraction of about 0.10 would represent about the peak of present design know-how with large rockets fueled by liquid propellants such as oxygen-gasoline. The accompanying thrust-weight ratio would be about 2.0. Later, these factors are used as the basis of our calculations of the dimensions of the Sputnik launcher.

In recent years, two high-performance, single-stage rocket vehicles have been described in the press, the Viking II and the Aerobee-Hi. The highest altitude reached by the Viking in its series of vertical firings was 158 miles (compared with 114 miles for the V-2), whch corresponds to an effective launching velocity of 7300 ft/sec. The highest altitude reached by the Aerobee-Hi so far is 190 miles, which corresponds to an effective launching velocity of 8000 ft/sec. It is evident that the best structural design practice and powerplant technology of a few years ago could not have produced a single-stage satellite launching rocket.

Since it appears impractical and perhaps impossible to achieve the satellite launching velocity with a single-stage rocket, it (CONTINUED ON PAGE 50)

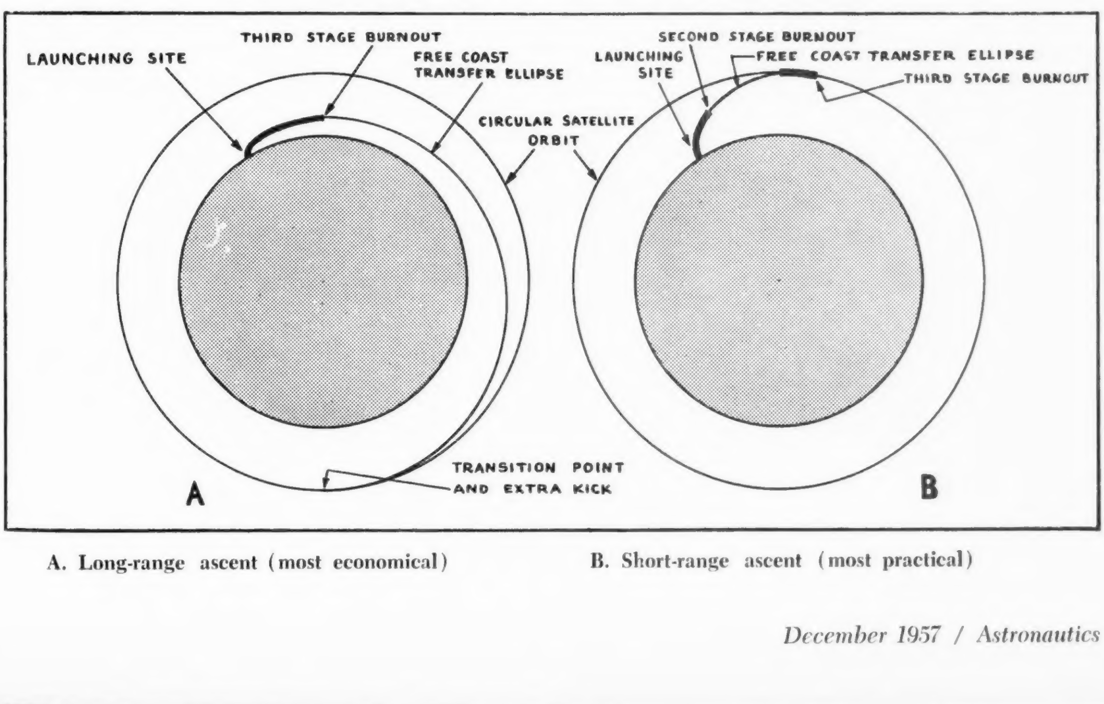
CALCULATED LAUNCHER CHARACTERISTICS OF SPUTNIK I AND RUSSIAN IRBM, COMPARED WITH VIKING 11 AND VANGUARD

Launcher	Viking-11	VANGUARD			SPUTNIK I			IRBM
Characteristics	Single-stage	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Single-stage
Thrust (F), lb (avg.)	21,000	27,000	8,000	2,000	250,000	62,500	12,500	250,000
Full Weight (M_f), lb	15,000	22,000	2,400	270	125,000	25,000	2,500	106,000
Payload (M_l), lb	825	2,400	270	21	25,000	2,500	500	6,000
Propellant (M_p), lb	11,990	—	—	—	87,500	19,500	1,625	89,400
Dead Weight (M_s), lb	2,185	—	—	—	12,500	3,000	375	10,600
Payload Fraction (l)	0.055	0.109	0.112	0.078	0.200	0.100	0.200	0.0566
Dead-Weight Fraction (s)	0.146	—	—	—	0.100	0.120	0.150	0.100
Thrust/Weight Ratio (r)	1.40	1.23	3.33	7.40	2.00	2.50	5.00	2.36
Propellant	Oxy-alcohol	Oxy-gas	RFNA-UDMH	Solid	Oxy-kerosene	Oxy-kerosene	Solid	Oxy-kerosene
Avg. I_{sp} (sec)	200	260	275	245	260	270	250	260
Firing time (sec)	103	~160	~60	~30	91.0	84.3	32.5	93.0
Initial Velocity, fps	0	0	5,500	~12,000	0	6,960	16,100	0
Burnout Velocity, fps	6,300	5,500	13,500	24,000	6,960	17,500	24,540	11,600
Elevation at *BO*, deg	90	~45	~30	0	45	23	0	42
Coast time after *BO*, sec	195	0	~200	∞	0	180	∞	576
Coast distance after *BO*, miles	116	0	~400	∞	0	550	∞	900
Slingshot Velocity, fps	—	—	—	1,150	—	—	640	—
Absolute Velocity, fps	—	—	—	25,150	—	—	25,180	—
Altitude at *BO*, miles	42	—	—	300	—	—	300	65
Summit Altitude, miles	158	—	—	300	—	—	300	280

Notes:

Viking 11 data are based on released information.
Vanguard data are based on official releases and on estimates.
Sputnik and Russian IRBM data are calculated estimates.

TWO ALTERNATIVE TRANSFER ELLIPSES



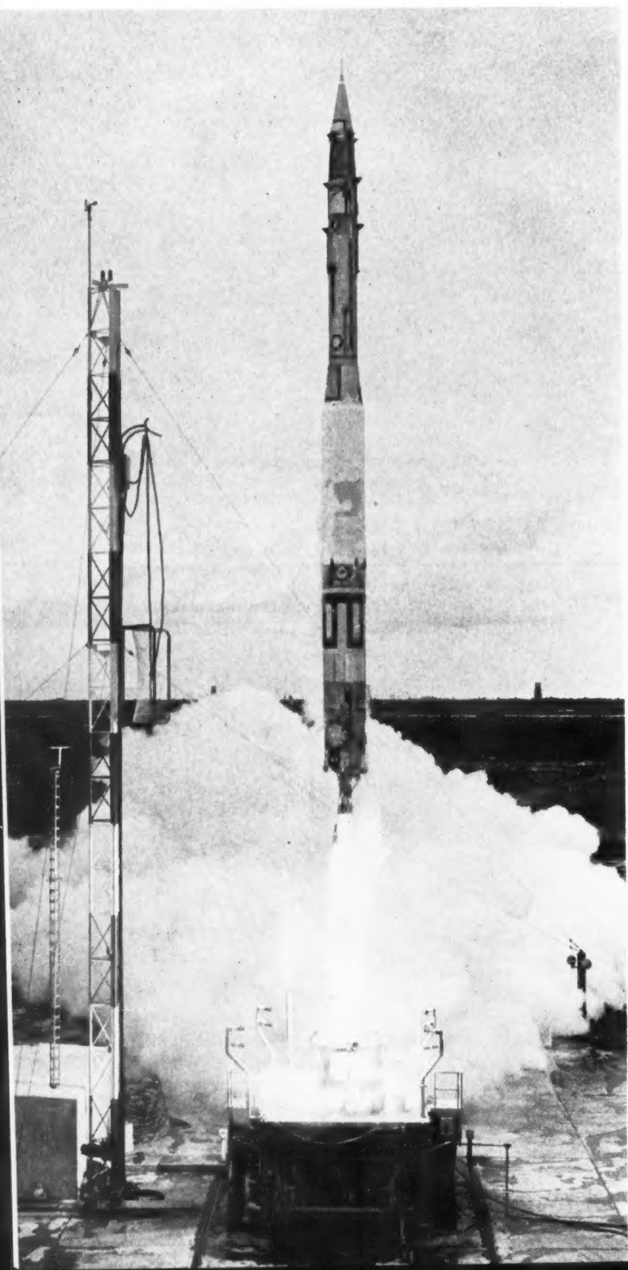
A. Long-range ascent (most economical) **B. Short-range ascent (most practical)**

After Sputnik—what?

Scientists are hopeful the Red satellites will focus attention on the status of science in this country and force a realization that basic research is as important as development of new weapons systems

By William R. Bennett

WASHINGTON CORRESPONDENT OF ASTRONAUTICS



FROM THE perspective of 1967, we may all look back gratefully to the fact that the Soviet Union was first with an earth satellite. This is the view of many scientists, one of whom said recently: "It's one of the best things that's happened. Sputnik has pointed up for laymen, including public officials, that Russia is a fully competent country. That's no news to technicians, but it seems to have panicked a lot of other people. Now the U. S. is being forced to reassess its programs, and maybe that's very healthy."

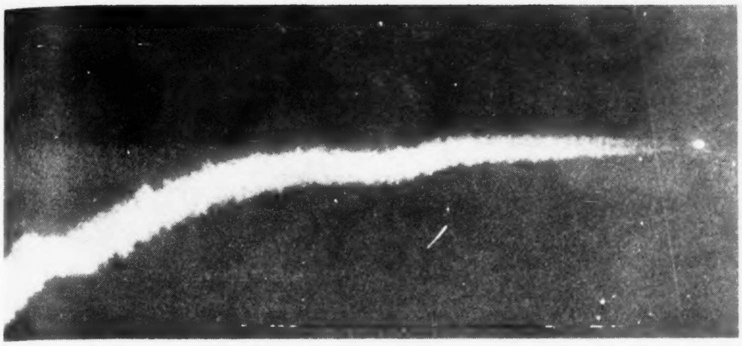
These sentiments reflect the confident hope that, at long last, the U. S. will bestir itself in behalf of science—including everything from better preparatory education to support of esoteric research projects.

Warnings Went Unheeded

Such are the terms in which members of the scientific community assess the impact of Sputnik. Along with almost everyone else, they recognize that the U. S. booted one, diplomatically and psychologically, by letting the Communists be the first to put up a satellite. (Some foresaw the consequences long ago, but their warnings went unheeded.)

With regard to ballistic weapons, however, few experts are ready to panic. Despite Moscow's boasts and the calamity howling in portions of the domestic press, well-informed missilemen think the

Photos on these pages show one effect of Sputniks—relaxation of security on news of U. S. rocket and missile firings. Here, Vanguard launching vehicle roars skyward in successful test of first-stage engine in mid-October.



At left, AF Thor leaves wide vapor trail across sky in successful launching from Cape Canaveral. At right, night firing of Army's Jupiter.

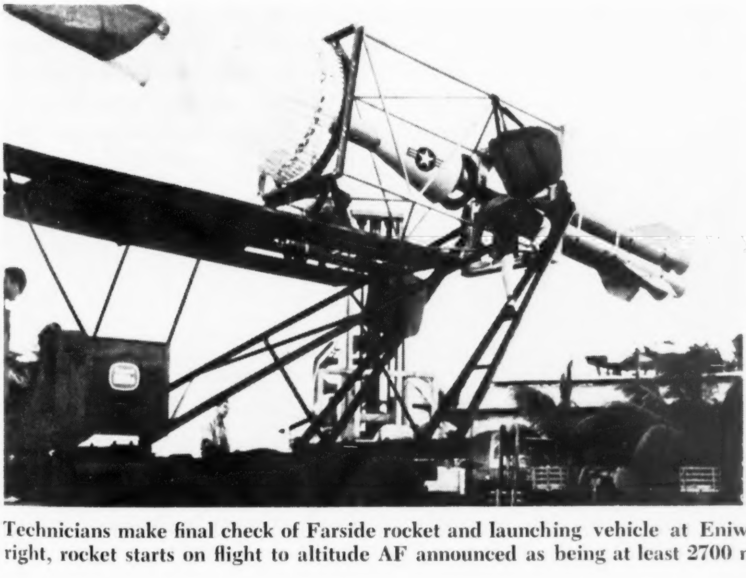
U. S. may be even with—or even ahead of—the Soviets when it comes to possessing a truly operational ICBM.

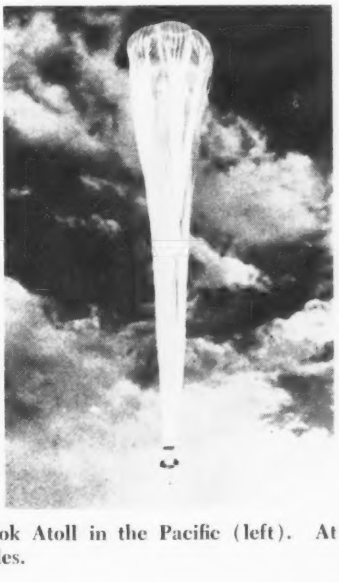
A lot has been said in criticism of Vanguard's separation from the military missile program. Those close to the satellite effort are by no means convinced the arrangement was a mistake. It has offered advantages, as well as disadvantages, for the Vanguard team. Some persist in believing that the decision will yet prove wise, and that, ultimately, we shall as a result have a better military vehicle, as well as a more useful satellite.

For the Sputniks, there is unconcealed admiration among the experts. There is a suspicion—the vaguest kind of guess—that instrumentation may be unsophisticated by our standards. But weights and orbits are impressive, and they are already contributing to U. S. knowledge.

Experts at the Naval Research Laboratory lean to the belief that Sputnik I transmitted temperature information only. Signals that appeared to be an elaborate code were, it's suggested, merely a propagation freak. So far, the Soviets have been unhelpful about releasing any code, or details of satellite construction, that would facilitate accumulation of knowledge.

Sputnik I's perigee—about 130 miles—has occasioned some surprise. Atmospheric density at these altitudes has clearly been overestimated, and it now appears that orbits with (CONTINUED ON PAGE 79)





Technicians make final check of Farside rocket and launching vehicle at Eniwetok Atoll in the Pacific (left). At right, rocket starts on flight to altitude AF announced as being at least 2700 miles.

Terre Haute, Ind., Moonwatch team at work. Teams of this type throughout the world play a major role in satellite tracking.

Eyes on the sky

A brief description of the optical and visual tracking program now being used to establish the Sputnik orbits, based on a paper by Fred L. Whipple and J. Allen Hynek presented at the IAF Barcelona parley

INTEREST in tracking of artificial earth satellites reached a new high with the successful Soviet Sputnik launching early in October. A timely description of the U. S. optical and visual tracking program, which has been given a good workout by the Red satellites, was contained in a paper by Fred L. Whipple and J. Allen Hynek of the Smithsonian Astrophysical Observatory and Harvard College Observatory (ARS Preprint No. 500-57), presented at the Eighth IAF Congress in Barcelona.

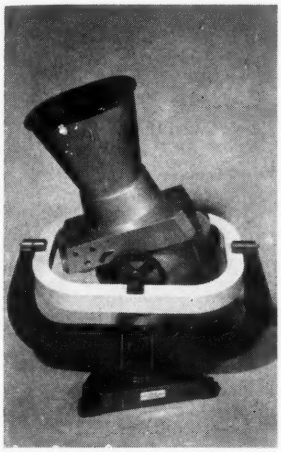
The program, the authors note in the paper, is made up of three separate and distinct parts—Operation Moonwatch, the visual search and acquisition program; the high-precision photographic tracking program; and a communications, computation and data analysis program centered on the offices of the Smithsonian Astrophysical Observatory.

The Moonwatch program consists of volunteer groups, each with 12 or more nonprofessional observers equipped with small telescopes. These telescopes, of 50 mm aperture and 12 deg field, patrol a large arc of the meridian at twilight periods during the early stages of satellite launching and in the very last stages, when the "moon" finally plummets down through the lower atmosphere. There are today nearly 100 Moonwatch groups in the U. S., plus 50 more in other parts of the world. In the case of the first satellite, the Moonwatch teams gave invaluable observations.

In cases of radio failure or radioless satellites, Moonwatch groups act as a search and acquisition corps to spot lost satellites and provide tracking information for use in orbit calculations. When such data are sufficiently accurate, tracking can be continued by the precision photographic stations.

Drs. Whipple and Hynek noted in their paper that, with the potentiality for satellites launched into orbits of higher inclinations than 35 deg to the equator, a need exists for teams in latitudes higher than 35-40 deg north and south. This observation was emphasized by Sputnik I whose orbit is inclined 65 deg to the equator.

THE SMITHSONIAN IGY SATELLITE TRACKING CAMERA



What it is: A wide-angle telescopic camera of the Schmidt type, 10 ft high, 9 ft wide and 6 ft deep, weighing almost 3 tons.

Who made it: Boller & Chivens, Inc. and Joseph Nunn & Associates of South Pasadena, Calif., are jointly responsible for design, manufacture and assembly. Mirrors and special lenses are made by Perkin-Elmer Corp. of Norwalk, Conn. The optical system was designed by Dr. James Baker of Harvard University.

How it is made: The optical system consists of a 31 in. diam spherical mirror and three 20 in. diam correcting lenses. Strip film is stretched over a curved surface at the focus of the mirror. Camera speed is F/1. The camera can be turned to face any part of the sky. Operation is automatic once the controls have been set in accordance with a satellite's expected orbit.

How it works: The camera takes two pictures on each strip of film. The first is taken while the camera is fixed on and following the satellite, with the time to the nearest 0.001 sec recorded on the picture. The second exposure is made while the camera is fixed on the background stars and moves with them, thus providing a point of reference for locating the satellite. Individual pictures will measure about 2 by 12 in.

They also emphasize the value of the Moonwatch organization to the satellite program, not only from the standpoint of important observations at the initial and final stages of a satellite's life, but, equally important, "as the means of training new observers and of interesting technically qualified people in the space age, which so clearly is at its dawn."

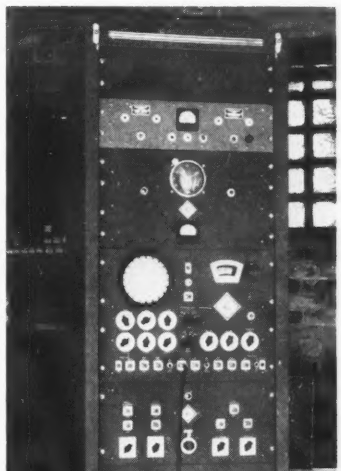
The photographic program centers on use of the Baker-Nunn tracking camera, especially developed for the operation. The camera is used in conjunction with a crystal clock which allows a precision time standard to be maintained at each station. Time is recorded on each satellite photograph so that it can be read to 0.001 sec.

The camera is expected to provide good image qualities over a field 30 deg in diam, although in practice film covering a field of only 5 by 30 deg will be used. Camera mounting involves three axes, so that the telescope can be pointed at any part of the sky and the film oriented along an arbitrary great circle. The telescope can then follow motion along this circle at any angular rate up to 2 deg per sec with a precision of about 1 per cent of the motion.

Operation of Camera Is Cyclical

Operation of the camera is cyclical, consisting of motion following expected satellite angular motion and motion to follow the fixed stellar background as a fiduciary system. A rapidly rotating shutter is synchronized with the exposure system so that clock time can be photographed at a known position of the rotating shutter during each exposure.

Use of strip film makes possible quick film changes, so that short exposures (of the order of 0.2 sec) are possible in bright twilight conditions. The telescopes can photograph 50 cm satellites to a distance of 2,500 km or more and 6 m spheres to the distance of the moon. (CONTINUED ON PAGE 76)



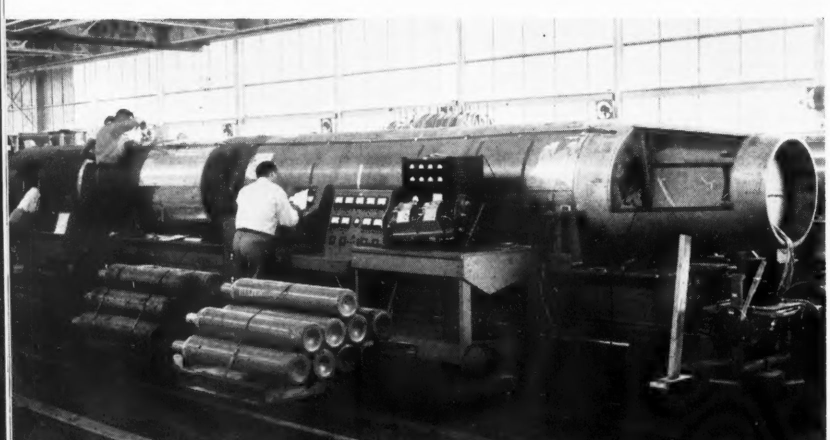
Crystal clock to be used with the satellite tracking camera. An electronic device, it can measure time to 0.0001 sec.

Building the Vanguard vehicle

Steps in assembly of the three-stage rocket which will launch U.S. satellite are shown for the first time in these Martin Co. photos

Kerosene fuel tank which makes up about half of first stage of Vanguard launching vehicle is inspected at Martin Co. Baltimore plant.

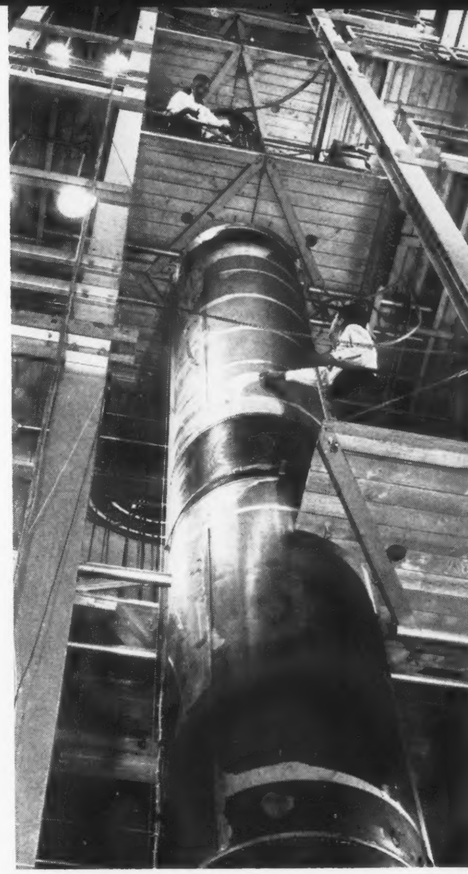
Powerplant installation technician connects LOX lines in first stage.



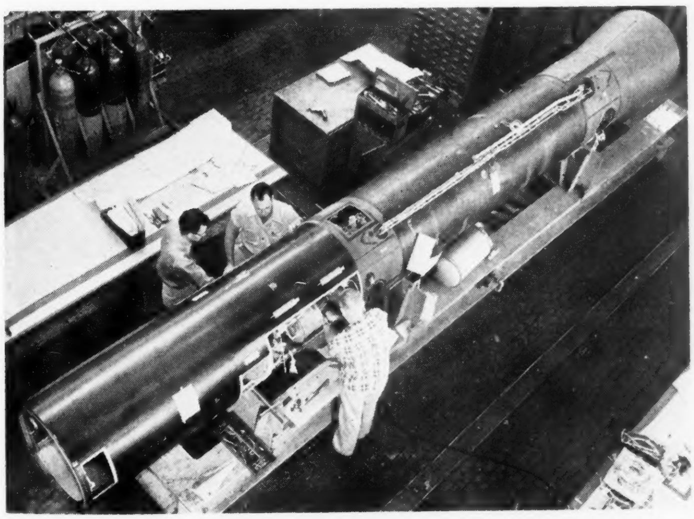
Horizontal test of first stage is conducted by four Martin technicians.

Electrical installations technician adjusts control wiring in bottom of first stage.

View through splicing jig of forward end of first stage. Jig, aligned to accuracy of .045 in., is used to join first and second stages.



Two Martin employes inspect the launching vehicle in the test tower at the company's main plant in Baltimore.



Bird's-eye view of second stage, showing technicians working on vehicle's "brains," located near nose end at left.

Asbestos plastic nose cones, here wrapped in dust-free seals, will be used to protect satellite on its trip up to orbital altitude. Molded by Martin in two parts, cones will split apart and drop off when launching vehicle is above densest part of atmosphere.

Space flight goes to school

University of California College of Engineering to offer 18-week space technology course at the graduate level beginning next month

By L. M. K. Boelter

DEAN, COLLEGE OF ENGINEERING, UNIVERSITY OF CALIFORNIA, LOS ANGELES

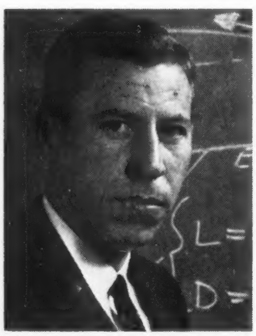
Howard Seifert
Coordinator

THE TECHNOLOGY of transportation and communication in extra-terrestrial regions has now reached such a degree of maturity that it provides subject matter for a systematic lecture series at the graduate level of difficulty. Such a series will be offered for the first time by the University of California through Engineering Extension, under the title, "Space Technology." The first of 18 weekly lectures will be given on the evening of Jan. 13 in Los Angeles, and will be followed by repeat lectures on Jan. 14 in San Diego and on Jan. 15 in the San Francisco Bay area. A similar schedule will be followed in future lectures.

Each evening will be shared by two prominent specialists, and the accumulated lecture notes of the total group of 36 speakers will be edited and published at the conclusion of the course. This procedure was followed quite successfully in previous years with courses in automation, modern physics and other timely subjects. Howard S. Seifert, visiting professor of engineering at UCLA and member of the Ramo-Wooldridge Corp. technical staff, will act as coordinating chairman of the lectures, as well as editor of the resulting book.

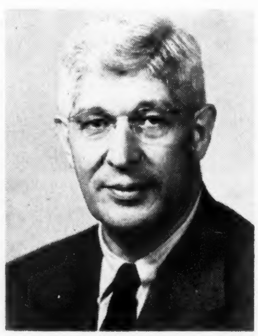
It is the aim of this course to provide a sound, yet imaginative exposition of the fundamental principles of (CONTINUED ON PAGE 67)

Among the Lecturers......................

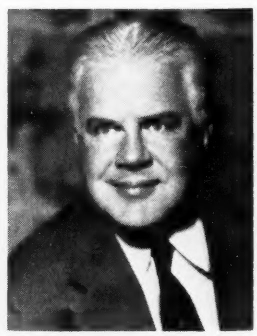


Alfred J. Eggers

Krafft Ehricke



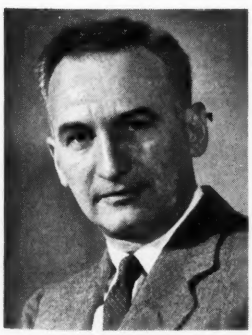
Joseph Kaplan



Richard W. Porter

LECTURE SCHEDULE—SPACE TECHNOLOGY COURSE

	SUBJECT	LECTURER	AFFILIATION
1.	Why Space Technology?	Dean L. M. K. Boelter	Univ. of California at Los Angeles
		H. Guyford Stever	Mass. Institute of Technology
2.	Reaction Propulsion in One and Two Dimensions	Martin Summerfield	Princeton University
		Burton Fried	Ramo-Wooldridge
3.	Orbits and Satellites	Samuel Herrick	Univ. of California at Los Angeles
		Joseph W. Siry	Naval Research Lab.
4.	Lunar and Planetary Flight	R. W. Buchheim	Rand Corporation
		Krafft Ehricke	Convair
5.	Flight with Continuous Propulsion	David Langmuir	Ramo-Wooldridge
		Jack Irving	Ramo-Wooldridge
6.	Re-entry and Landing	Lester Lees	Calif. Institute of Technology
		Alfred A. Eggers	NACA
7.	Rocket Theory and Liquid Engine Design	Howard Seifert	Univ. of California at Los Angeles and Ramo-Wooldridge
		George Sutton	Rocketdyne
8.	Solid Engine Design and Future New Rockets	John Shafer	Jet Propulsion Lab.
		Robert W. Bussard	Los Alamos Sci. Lab.
9.	Structural Analysis and Design Practice	Millard Barton	Ramo-Wooldridge
		Ernest E. Sechler	Calif. Institute of Technology
10.	Communication: Feasibility and Hardware	Eberhardt Rechtin	Jet Propulsion Lab.
		Frank Lehan	Ramo-Wooldridge
11.	Guidance: Radio and Inertial	W. H. Pickering	Jet Propulsion Lab.
		Wm. Russell	Ramo-Wooldridge
12.	Radio-Inertial Guidance and Mid-course Navigation	Donald P. Ling	Bell Telephone Labs.
		Albert D. Wheelon	Ramo-Wooldridge
13.	Space Medicine: Physical Environment and Human Ecology	Heinz Haber	Univ. of California at Los Angeles
		Hubertus Strughold	USAF School of Aviation Medicine
14.	Space Medicine: Cabin Design and Crew Performance	Alfred M. Mayo	Douglas
		Craig L. Taylor	Univ. of California at Los Angeles
15.	IGY Progress and Satellite Experiments	Joseph Kaplan	Univ. of California at Los Angeles
		James van Allen	State Univ. of Iowa
16.	Exploration of Mars; Magnetohydrodynamics	Wernher von Braun	Army Ballistic Missile Agency
		Milton Clauser	Ramo-Wooldridge
17.	What the Future Holds—Panel Discussion	Simon Ramo (Chairman)	Ramo-Wooldridge
		H. Guyford Stever	Mass. Institute of Technology
		Arthur Kantrowitz	AVCO Mfg. Co.
		Richard W. Porter	General Electric
18.	Final Examination	H. Seifert	Ramo-Wooldridge



Simon Ramo

Martin Summerfield

George Sutton

Wernher von Braun

Suite 304, the Ritz, Barcelona

By Andrew G. Haley

NEW IAF PRESIDENT

Andrew G. Haley, newly elected president of the International Astronautical Federation, has devoted a major part of his lifetime to "working with his hands in rocketry." A lawyer by profession, he is a Past President of the AMERICAN ROCKET SOCIETY and is now a Director and General Counsel of the Society. He was Chairman of the first ARS Space Flight Committee and it was during his two-year tenure in this office that the Committee recommended the establishment of a U. S. satellite program. He was also cofounder, president and general manager of Aerojet Engineering Corp., during World War II.

THEODORE VON KÁRMÁN and I, late as usual, departed from Paris by automobile for Barcelona and the 8th International Astronautical Federation Congress on Oct. 3 after a visit with Giuseppi Gabrielli and his wife. Mrs. Gabrielli's father is Gen. G. A. Crocco, sponsor of the 7th IAF Congress, and her brother is Luigi Crocco of Princeton University.

V. Hercik, N. Gacciapuoti and H. M. Phillips, all of UNESCO, bade us farewell with assurances that there are many areas of mutual cooperation between the IAF and UNESCO.

En route to Barcelona, we were blissfully unaware of the Sputnik bombshell. We received a news report of the successful launching in Toulouse somewhat unbelievingly, but proceeded immediately into an area on the border between France and Spain, where no further details were available.

It was not until we reached Barcelona on Saturday night, Oct. 5, that we were greeted with the few facts known at the time about the launching. Wearily, we followed our porter to Suite 304 of the Ritz Hotel, which was to be our headquarters for the meeting.

News Hawks Descended on Hotel

On Sunday, we attended the receptions and preliminary meetings, greeted old friends, and so on, and then the news hawks descended on us. I, personally, was well-located strategically. I could always turn the reporters over to the ever-patient and kindly Dr. von Kármán, or to any one of the numerous scientists who were always in our suite. S. F. Singer, the gifted University of Maryland scientist, was just down the hall from us, as was Samuel Herrick, the UCLA astronomer, and in the hotel were many other members of the American delegation, including Maj. David G. Simons and Mr. and Mrs. Otto Winzen.

This arrangement was really excellent, as far as I was concerned, since I could always refer the reporters to the numerous scientists in the hotel.

It's a little hard now to capture the alternating moods of excitement and despair caused by the Sputnik announcement, but, since I had little else to contribute except comments on the law, I became imbued with a furious desire to be the Paul Revere of Project Farside at this meeting. At every opportunity, I would silently slink into an empty room and call Washington, instructing my office to contact every appropriate official in the nation's Capital, Pasadena and even Eniwetok to find out, if possible, what was going on. I was determined to bring the good news to Barcelona even before the press. Needless to say, things just didn't work out that way.

I will never forget the routine with the newsmen. Here is a typical situation: Dr. von Kármán would be talking with *Life Magazine*, Dr. Singer with the *New York Times*, Wolfgang B. Klemperer with the Associated Press, and Dr. Herrick with the United Press, while I would be trying to make sense with my (by then) bosom pal from International News Service. INS liked to roam around with me since I would be emceeing the interviews and INS could pick up the general gist of everything that was being said. The routine was always the same. I would make the introductions, and the reporter and the scientist would sit down side by side, and out would come the notebook and pencil of one, and the slide rule of the other.

Sunday was the worst day. Only brief information about Sputnik was contained in the Barcelona papers, and Spanish censorship prevented distribution of any foreign newspapers. The reporters asked good questions, but primitive ones at first, but as the day went on the reporters became more and more sophisticated and philosophical. On the first day, our scientists commented somewhat as follows:

How many stages? Most probably three.

The thrust of each stage? Many answers, but general agreement to total thrust in the order of 270,000 lb.

Burning duration and acceleration of each stage? About 2 min for first stage to about 4500 mph. Burning duration thereafter was considered too conjectural, but the second stage must have brought the satellite to about 12,000 mph and the final stage to the order of 18,000 mph.

How long would the beep last? Hard to estimate, but on the basis of conjecture that Doppler or DOVAP equipment was being used, from four to seven weeks.

Most of the conjecture was fairly well cleared up by the end of the Congress, especially when a brief description of the launching vehicle by Y. A. Pobedonostsev, taken from an article in *Sovietskaya Aviatsia*, was circulated. The few details given confirmed the guesses mentioned above.

Revision of Constitution Planned

The business meetings of the IAF were chiefly concerned with remedial actions to cover: (1) Correction and revision of the IAF Constitution; (2) assurances that the 9th and succeeding Congresses will be furnished with technical sessions of excellence, keynoted in person by the world's greatest experts in the fields of the specific sessions; (3) a program to strengthen *Astronautica Acta* from the standpoint of content and circulation; and (4) assurance of the stability (CONTINUED ON PAGE 70)

Outgoing IAF President Leslie R. Shepherd of Great Britain (right) holds the floor at Plenary Session as (left to right) Joseph A. Stemmer of Switzerland, IAF Secretary, Leonid I. Sedov of the U.S.S.R. and Julio Marial of Spain, IAF vice-presidents, listen.

Another scene at Plenary Session. Seated (left to right) are Anatolij Karpienko, Lydia Kurnosova and Alla T. Masevitch, all of the Moscow Academy of Science; Gerald C. Cross, vice-chairman of the ARS delegation; the author; and Ross Fleisig, representing the American Astronautical Society.

Maj. David G. Simons (center) makes a point as Otto Winzen (left) and Russia's Leonid Sedov listen attentively during a break in the technical sessions.

missile market

Financial news of the rocket and guided missile industry

BY ROBERT KENMORE

SPUTNIK helped stem the downward trend in the missile index in October while the general market continued its decline unabated.

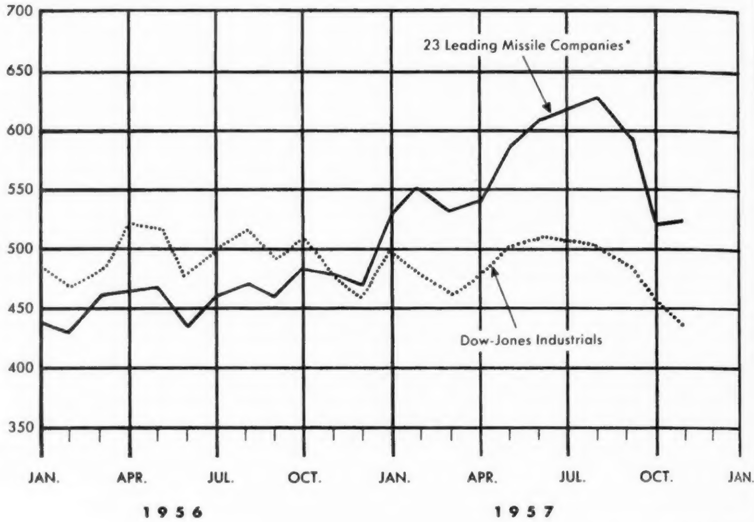
Most observers have been taking the position that we are now in a "major" bear market, and that we have been in it for quite a while. Since these same prophets of doom were as recently as a few weeks ago still trying to forecast when the end of the "current" bull market would come, it appears to this writer that the prevailing attitude at this time is unduly pessimistic. This is especially true as regards the rocket and guided missile segment of the market.

The following factors seem pertinent in analyzing the current situation: Russia's new get-tough attitude, following its announcements of weapon superiority, leaves little doubt as to the only possible course which the U. S. can follow. Regardless of any budgetary, political or interservice considerations, we must show the world that ours would still be the winning side in any eventual showdown. This will take crash programs and large sums of money. Strictly on the political side, the administration cannot afford to take the responsibility for a lag in technological advancement in the rocket guided missile and space flight fields in the face of Russian progress in this area. Current market psychology is evidenced by an extreme state of nervousness on the part of investors, and day-to-day swings hinging on spot news announcements have been of extremely sizable proportions. A typical example of this latter is the October performance of the common stock of General Dynamics. It started and ended the month at $51 per share. During the month, however, it had a high of $54^3/_4$ and a low of $46^3/_4$. This represents a difference in evaluation of the company's worth in the neighborhood of $62 million. During this same period, Aerojet stock moved up 45 points in one day. In so doing, the stock only regained some of the territory it had lost in previous weeks.

No wonder, then, that we continue to advocate long-trend investments based on appraisal of values, rather than short-term buying or selling on impulse.

Business is good, and the economy sound—perhaps not as good as last year, but still sound. While some dislocations will undoubtedly occur in missile programming, we are still a long way from an environment which gives credence to the prophets of gloom.

THE MARKET AT A GLANCE



*Index compiled June, 1955

	November 1957	October 1957	% Change	November 1956	% Change
Dow-Jones Industrials	435	457	−4.8	488	−10.9
23 Missile Companies	524	518	+1.2	479	+ 8.6

Market Letter Gleanings

United Business Service's supervised list of recommended stocks includes *Sperry Rand* and *Thompson Products* (medium quality issues with strong growth trend); *Litton Industries* (speculative growth stock); *Boeing* and *North American Aviation* (well-established companies offering good profit possibilities); and *General Dynamics* and *Martin* (speculative issues for high percentage gains).

Dean, Witter has a 10-page report on *Litton Industries*.

J. R. Williston & Co. finds *Thiokol* "an attractive issue at this time."

"Selling well below its high of $47^7/_8$, *Martin* represents interesting appreciation prospects at this time." (Kerbs, Haney & Co.)

"We regard current depressed prices for *General Dynamics* common stock as an excellent buying opportunity . . . . ." (Fahnestock & Co.)

"At around current prices, *Douglas Aircraft* is not only an interesting speculation, but a good investment with a yield approximating $6^1/_2$ per cent." (Thompson & McKinnon)

"*Chance Vought* merits attention with estimated 1957 earnings of $4 to $5 per share. On this basis, we estimate a reasonable value for these shares to be in the range of $35 per share." (Bache & Co.)

Financial Briefs

. . . . . *Litton* continues acquisition spree, plans to acquire two more firms in addition to the three already announced (Monroe Calculating Machine, Aircraft Radio, Maryland Electronics), which have already more than tripled its potential level of sales.

. . . . . *Thiokol* pays 5 per cent dividend, plans 2-for-1 split in January.

. . . . . *Bell* president says half of this year's expected earnings of $4.2 million will come from commercial business.

. . . . . *Northrop* earns $3.62 per share in fiscal year ending July 31, versus $3.28 in previous year, puts April 30 backlog at $279 million.

(CONTINUED ON PAGE 84)

Launching Problems

(CONTINUED FROM PAGE 36)

is necessary to resort to the mechanically more complicated solution of multi-staging. Early examples of multi-stage rockets are the three-stage solid propellant Rheinbote, developed in 1943 in Germany, and the two-stage liquid propellant Bumper, developed in 1949 in the United States.

The main idea is that a large first-stage rocket is employed as a booster for a smaller second-stage rocket that it carries as a payload, and this rocket in turn boosts a smaller third-stage rocket, and so on, depending on the number of stages selected. It is clear that, in this way, any desired peak altitude or maximum velocity can be attained. The price that has to be paid for such unlimited performance capability is, of course, that a very large rocket assembly is needed to propel a useful payload of only modest size.

One consideration that arises immediately in the analysis of the multi-staging technique is the optimization of the firing program. Should Stage 2 be ignited immediately after the exhaustion of Stage 1, at the moment when Stage 2 has the highest possible initial velocity V_o? Or should firing be delayed until after a suitable coasting period to take advantage of the additional range that might thus be gained? The question can be generalized: For a multi-stage rocket, what is the optimum power-off coasting period between successive stages?

Multi-Stage Programming

It can be shown mathematically that, if the entire powered trajectory is vertical, there should be no coasting period at all between stages. The illustration on page 36 serves to explain the argument. If we consider two rocket stages of unequal size but similar design (same values of I_{sp}, l, s, r), then by the performance equation in the first illustration their burnout velocities and summit altitudes should be the same if launched individually from the ground at rest. If the large stage carries the small stage as a payload, and if the second firing is delayed until after the large stage has coasted to its summit, the maximum altitude reached will be *twice* the summit altitude of a single stage. On the other hand, if the second firing takes place without delay, the burnout velocity of the second stage will be twice that of a single stage, and therefore the maximum altitude will be about *four times* that of a single stage. Clearly, the no-coasting type of firing program results in the highest over-all performance.

The performance penalty that results from inter-stage coasting is most severe in the case of vertical flight, for example, the Farside project. It is much less severe in the case of horizontal flight, for example, a satellite project. As a result, inter-stage coasting may be acceptable in a satellite firing program if practical considerations should require it.

Summarizing, three principles of multi-staging emerge from the above: (1) Inter-stage coasting is to be avoided, if possible and the final burnout velocity will then be n times that of a single stage, where n is the number of equivalent stages; (2) the range or summit altitude of an n-stage rocket fired with no inter-stage coasting is about n^2 times that of a single stage; (3) the over-all payload fraction l_n of an n-stage rocket of such performance is much smaller than the payload fraction l of a single stage, that is, $l_n = (l)^n$.

We have seen that the minimum effective launching velocity required to place a satellite in a close-in orbit is about 27,000 ft/sec. From the rocket performance equation and from the above principles of multi-staging, it is clear that the rocket launcher is utilized most effectively if the several stages are fired in close succession in as short a period of powered flight as possible. The velocity vector at burnout should be horizontal to achieve a circular orbit. But, if the point of burnout turns out to be at a lower altitude than the intended orbit, a coasting climb will take place along a so-called transfer ellipse before the satellite can enter the circular orbit. The velocity vector at burnout may then have to be inclined above the horizontal, depending on the point that is chosen for transition from the transfer ellipse to the circular orbit.

At this point of intersection, an additional propulsive impulse will be needed to effect the transition from the transfer ellipse to the circular orbit—that is, to change either the magnitude of the velocity vector, or its direction,

Two Hats for Talos

Talos is raised into position on land-based launcher at White Sands.

Now undergoing evaluation by the Army at White Sands Proving Ground, the supersonic surface-to-air Talos may soon find a place in the U. S. continental air defense system.

Meanwhile, the Navy, original contractors for the missile, announces that it will go into operation with the fleet early next year. It will first appear on the light cruiser USS Galveston, now undergoing conversion at the Philadelphia Naval Shipyard, sometime in April, 1958. The following year, the cruisers Little Rock and Oklahoma City will have the missile when they rejoin the fleet. And the first nuclear-powered cruiser, USS Long Beach, will also be armed with the weapon.

Talos was developed by the Navy in conjunction with the Applied Physics Laboratory of Johns Hopkins University. Bendix is the prime contractor on the missile, McDonnell provides the ramjet engine, International Telephone and Telegraph is a major subcontractor on guidance and control units, and Sperry Gyroscope supplies the SPG-49 radar guidance system. The land-based version of the missile system, TDU (Talos Defense Unit), will be built by RCA.

The present version of the Talos is 20 ft long, 30 in. diam and weighs 3000 lb. It has a solid propellant booster that is 10 ft long. Its ramjet engine uses kerosene as fuel and is equivalent to a controllable 40,000 hp motor. The missile is capable of carrying either a high explosive or atomic warhead. Its range is "in excess of 25 miles."

The Talos guidance system is a two-stage affair. The first, or mid-course stage, carries the missile from the launcher to the vicinity of the target. This stage is based on a beam riding system similar to that used in the Terrier. Once in the vicinity of the target, the missile switches to a homing system, tying in on the target until it hits home.

or both. The amount of this additional impulse can be minimized by selecting a transfer ellipse that is tangent to the circular orbit at the transition point and for which the total energy per unit mass is as close as possible to that of the circular orbit, as shown in Example A of the illustration on page 37.

The perigee of this ellipse is only a short distance from the launching site, and the apogee is at the point of tangency halfway around the earth. The additional "kick" needed to effect transition at this point is less than 500 ft/sec, for a close-in circular orbit. In our definition of "effective launching velocity," the velocity increment that has to be given to the satellite at the transition point is added to that delivered by the main launching rocket to obtain a fair measure of the V_L required for this particular path of ascent.

Optimizing Path of Ascent

We conclude from the above that the optimum path of ascent that minimizes the required V_L is a transfer ellipse that injects the satellite into its orbit at a point halfway around the world. This is impractical, however, for two reasons. First, the payload capacity of the rocket launching system would be compromised by the need to project a fourth-stage transition rocket up to the satellite orbit along with the satellite. Second, it would probably be a difficult matter to control the orientation of the small transition rocket during the 45-min coasting period so that it will point in the right direction at the moment of firing.

As an extreme alternative to this long distance ascent, there is a vertically upward path of ascent. The satellite launcher fires its first one or two stages directly upward, and, when the remainder of the multi-stage rocket reaches its summit at the height of the orbit and is about to fall downward, the rocket turns itself horizontal and fires the remaining stages, reaching orbital velocity at burnout. In this way, the satellite would be placed in the circular orbit at the desired altitude.

The disadvantage of this path of ascent can be demonstrated by a simple calculation of the effective launching velocity V_L required to carry it out. To reach an altitude of, say, 400 miles, an initial launching velocity of 11,600 ft/sec is needed; then, at the summit, starting from rest, a velocity of 24,800 ft/sec is needed to establish the orbit (see graph on page 20 in the November ASTRONAUTICS); the sum of these two propulsive effects, namely, 36,400 ft/sec, is the required V_L. Clearly, the vertical climb is a much more wasteful path of ascent when compared with the V_L of 27,100 ft/sec for the long distance ellipse.

Short-Range Ellipse Best

An intermediate type of path, one that we call a short-range ellipse, such as that shown in Example B of the illustration on page 37, is probably best. The firing program would call for firing the first two stages one after the other, tipping the rocket gradually toward the horizontal during the firing period. After burnout of the second stage, the remainder would continue to coast on an elliptic path (nearly parabolic because of its short range) until it arrives at the point of tangency with the horizontal direction of the intended circular orbit. At this point, the third-stage rocket fires in a horizontal direction, accelerating the satellite to orbital velocity.

A rough estimate of the penalty in V_L for this path can be computed in the following manner. Since the penalty arises only as a result of the interstage coast along the short-range transfer ellipse, the velocity loss is considered along that part of the path. As a reasonable example, we assume that burnout of the second stage occurs at 160 miles altitude, that the velocity vector at that moment is pointed 30 deg above the horizon, and that the velocity is 18,000 ft/sec.

After nearly 5 min of free coasting, the third stage will be at an altitude of about 400 miles, and it will be time to turn on the power of the third-stage rocket engine. At this moment, the velocity will be horizontal and about 15,600 ft/sec. This represents a loss of initial velocity for the third stage of about 2400 ft/sec. (While it is true that this simple computation ignores the potential energy gained on the coast period, it is reasonably correct to call this a loss in V_L.) The horizontal distance from the launching site to the end of the coasting path will be about 1000 miles.

We conclude that the penalty for a short-range transfer ellipse is acceptable, and that this path of ascent is therefore the most practical. Both the Vanguard and the Sputnik projects call for this type of path of ascent to the orbit. It was this calculated V_L penalty for the short-range ascent that was used in the table of effective launching velocities for ESV-2 in Part I of this paper, on page 20 of the November ASTRONAUTICS.

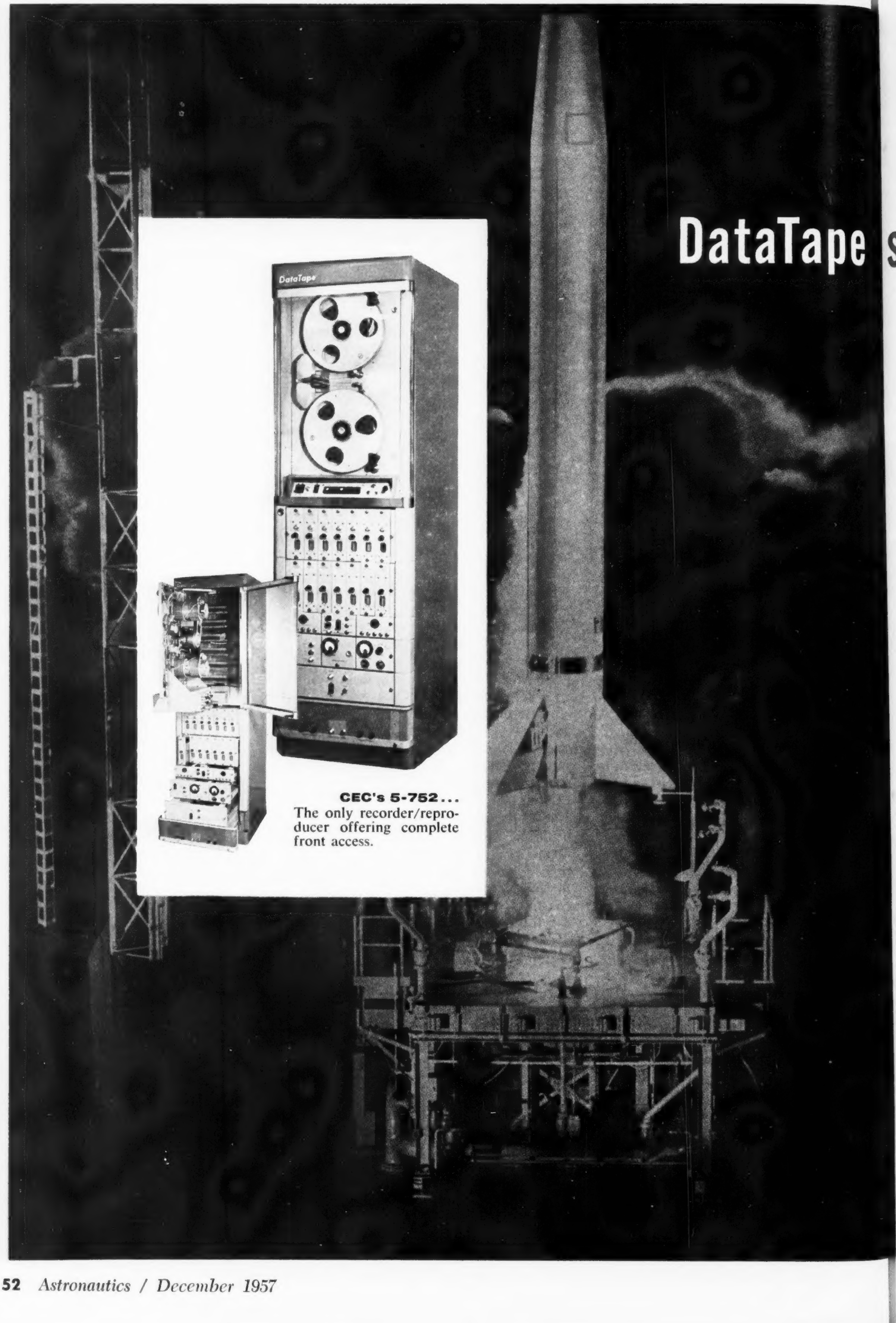
Having developed in the preceding sections the principles of rocket flight performance, of multi-staging, of firing programs, and of ascent paths, we are now prepared to analyze the Sputnik I launching problem.

Press reports supply the following data as our starting points. The weight of the first satellite is 184 lb, but the Russians have announced that the weight could be two to three times as heavy. If true, therefore we pick a payload of 500 lb. (This includes the weight of the nose cone that shielded the satellite, which was projected into the orbit along with it.) The firing duration of the first stage was said to be 1 to 2 min; we choose for our calculation a thrust/weight ratio that corresponds to a firing duration of 91 sec. Burnout velocities for the first and second stages were given as 7000 and 17,500 ft/sec, respectively, in round numbers, and we accept these figures. The third stage was reported to have coasted horizontally a distance of about 625 miles before it fired; we take this as the distance from the launching site to the point of transition at the end of the free-coast transfer ellipse. Finally, although the actual orbit of Sputnik I turned out to be an ellipse with an apogee at 550 miles altitude and a perigee at 200 miles, we shall say that it was intended to enter a circular orbit at a height of 300 miles, and that the launcher has the capacity to do this.

Sputnik Launcher Characteristics

Some additional specifications have to be assumed before we can proceed with the design. The propellants in the three stages were not disclosed. We take the first-stage propellant to be oxygen-kerosene with a specific impulse of 260 sec, an average value over the powered trajectory, between sea-level and burnout at about 30 miles altitude. The second-stage propellant is the same, with an I_{sp} of 270 sec at high altitudes. The third stage is a solid propellant rocket (capable of better impulse-weight ratio than liquid types in small sizes), and specific impulse is 250 sec, with nearly zero back pressure. These values correspond to the best of American experience, taken from the open literature. A loss of 1000 ft/sec in the burnout velocity of the first stage was allowed to take care of the atmospheric drag.

It is necessary to assume the dead-weight fractions s for each of the three stages. Viking II, a moderately high-performance, single-stage rocket, had an s-fraction of 0.146; rocket vehicles of greater range have been developed since then (Aerobee-Hi, Redstone, Thor, etc.). Therefore, for the large first stage, it is not unreasonable to take a dead-weight fraction of 0.100. For the smaller second stage, we take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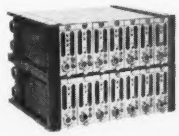

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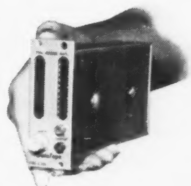

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0.120, and for the third stage we take 0.150.

We next have to assume the thrust-weight ratios *r* for each of the stages. Examination of the burnout velocity formula shows that the result is fairly insensitive to the value of *r* as long as it is not much less than 2. We take 2.0 for the first stage, 2.5 for the second stage, and 5.0 for the third stage.

Payload Assumptions

A final assumption to be made, also not very critical, is whether the payload fractions *l* for the three stages are equal or somewhat unequal. For certain practical reasons, we choose to make them unequal, to assign a smaller payload fraction to the second stage than to the first stage, but to place a larger fraction on the third solid-propellant stage than on the second stage.

Having made these assumptions, we can calculate without any significant ambiguity a complete description of the Sputnik I three-stage launching rocket, that is, thrusts, full weights, empty weights, firing times and burnout velocities. By assuming certain over-all densities and slenderness ratios, we can calculate the dimensions. The results are summarized in the table on page 37.

It is interesting to compare the Sputnik description with the specifications for Vanguard. The corresponding values are recorded in the table to the extent that they are obtainable from official releases and press reports. Also for comparison, the specifications of Viking II (Round No. 11) are listed in the same table.

The Sputnik I launcher, according to these calculations, is a three-stage rocket weighing 125,000 lb when loaded with propellant, and thrust of the first stage is 250,000 lb. The second stage has a thrust of 62,500 lb, and the third stage (solid propellant) has a thrust of 12,500 lb. If the over-all specific gravity of the first and second stages (fins and fairings removed) is taken to be 0.85, and if the third stage (less fairing, nose cone and payload) is assumed to have a specific gravity of 1.3, and if the slenderness ratio (length/diameter) of each stage is taken to be 8.0, then it can be calculated that the three-stage rocket with the sphere and nose cone on top stands 90 ft high and has a first-stage body diameter of $6^1/_2$ ft.

It is interesting to speculate on whether the engine of the first stage of the Sputnik rocket could have been the same as that used by the Russians in their single-stage IRBM that is capable of carrying an H-bomb warhead. For purposes of calculation, we shall assume that an H-bomb plus protective nose-cone (for re-entry into the atmosphere) weighs 6000 lb. Then, this 6000 lb payload is visualized in the first-stage rocket in place of the 25,000 lb payload that comprises the second and third stages of the Sputnik launcher. The gross weight is then 106,000 lb instead of 125,000 lb. If the assumed dead-weight fraction of 0.100 is retained, the structure of the IRBM would be lighter by 1900 lb, and if the thrust/weight ratio of 2.36 is accepted, the thrust of the IRBM would be 250,000 lb. This modified first stage, equipped with a 6000 lb H-bomb plus nose cone, would constitute an IRBM. It is straightforward to calculate that the burnout velocity of this missile is 11,600 ft/sec and that its range is 1000 miles.

We conclude that it is possible for the Russians to have developed their Sputnik launcher by adding two stages to their IRBM, that, in so doing, they added 1900 lb to the structure to enable it to support the heavier payload, but they made no change in the propulsion system.

Accuracy of Guidance

We can speculate also about the accuracy of the guidance systems of the Sputnik rocket and the IRBM. The Sputnik orbit is slightly elliptic, the difference in altitude from apogee to perigee being about 350 miles. If we assume that this was not intentional, that an exact circle was actually desired, then we must charge this 350-mile difference to an error in inertial guidance and a deviation in engine impulse. Let 175 miles be charged to guidance error and an equal amount to impulse error. It can be calculated, from the theory of elliptic orbits in a central force field, that an apogee-perigee difference of 175 miles for a close-in orbit would result from an error of 1.2 deg in elevation angle at final burnout. Since it took Sputnik 387 sec from the start of firing to reach the point of final burnout, we can say that the orientation control drifted from the planned program at the average rate of 0.003 deg per sec.

If so, the same guidance unit in an IRBM would produce an elevation error of 0.3 deg at burnout. An error in elevation is not serious if the direction is nearly that for maximum range, but the same error in azimuth would result in a lateral error of 5 miles at the target. Inasmuch as the successful launching of Sputnik is reported to have occurred on the first try, a claim that has not been seriously disputed, it implies that the Russian IRBM has good accuracy for military purposes.

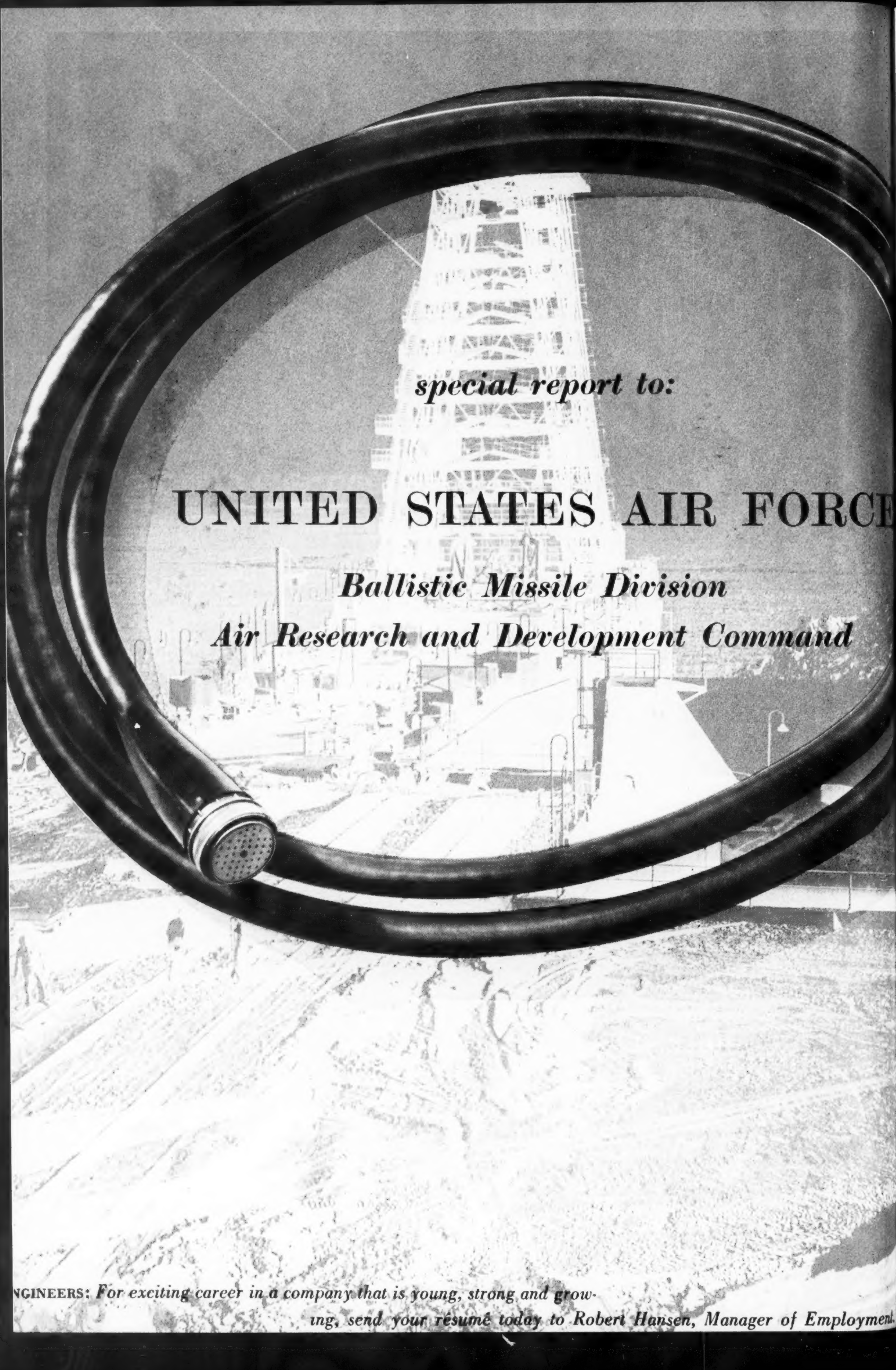
Another interesting calculation can be made. If the 500-lb satellite is replaced by a 500-lb solid-propellant rocket carrying a 50-lb instrument package as a payload, the resulting four-stage rocket could project this package away from the earth, and in particular to the moon. The inert projectile payload plus empty rocket, would weigh 150 lb.

As a final observation, we must realize that the thrust and weight figures given for the Sputnik rocket in the table are fairly sensitive to the assumed payload capacity (500 lb) and to the assumed dead-weight fractions. If the dead-weight fractions are raised by 10 per cent, the size of the three-stage rocket will have to be revised upward by about 20 per cent. If the payload capacity is eventually shown to be 600 instead of 500 lb, all thrust and weight figures will have to be increased by about 21 per cent. H. H. Koelle, in an article on page 32, states without identifying his source that the thrust of the Russian IRBM is 264,000 lb, whereas we have calculated 250,000 lb. If Mr. Koelle's figure is correct, this would substantiate the general analysis provided in this paper.

The original purpose of these two articles was to explain the problems of launching an earth satellite and to develop the principles on which these problems can be resolved. We shall leave it to the Russians to inform us at some future date as to the exact performance and design characteristics of the Sputnik launchers.

Sputnik II Launcher

The most recent satellite, Sputnik II, is reported to weigh 1120 lb, a figure that seems to include the empty third-stage rocket. The rocket system of Table 2 that we attribute to Sputnik I can project a satellite plus empty rocket weighing 875 lb. (The extra altitude of the orbit is of little importance.) This difference of 22 per cent might be the result of conservativism in our first guesses as to the Russian IRBM dead-weight factors. On the basis of the information available at this moment, it is unnecessary to assume, as some commentators have done, that the Russians are using high-energy propellants or nuclear fuels. If the news reports have been misinterpreted, if the 1120-lb weight does *not* include the empty third stage, then we must conclude either that a standard-fuel launcher of much larger thrust was used (about 400,000 lb) or that a high energy propellant was used. A launcher in the 400,000-lb class would correspond to an ICBM of 5000-mile range, which the Russians claim to have developed.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ARS news

Lowy, Hurst Named to Telemetering Committee

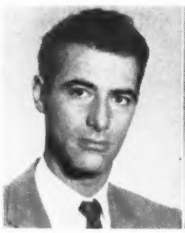
John J. Burke, chairman of the ARS Instrumentation and Guidance Committee, has appointed Max A. Lowy and William F. Hurst to the Executive Committee of the National Telemetering Conference.

The Conference, jointly sponsored by ARS, IAS, AIEE and ISA, will be held at the Lord Baltimore Hotel in Baltimore, Md., June 2–4, 1958. Already representing ARS on the Executive Committee is James J. Harford, for the national headquarters staff.

Mr. Lowy is a telemetry specialist with the Guided Missiles Research Div., Ramo-Wooldridge Corp., Los Angeles. A graduate of Brooklyn Poly, he was formerly with the Jet Propulsion Laboratory at Cal Tech.

Mr. Hurst, an alumnus of the University of Denver, is director of quality control at Hallamore Electronics Co., Anaheim, Calif.

The tentative program for the meeting includes sessions on point-to-point U. S. and foreign telemetry systems and techniques, mobile U. S. and foreign systems and techniques, the use of telemetry in U. S. and foreign IGY programs, and discussions of current problems in telemetry.

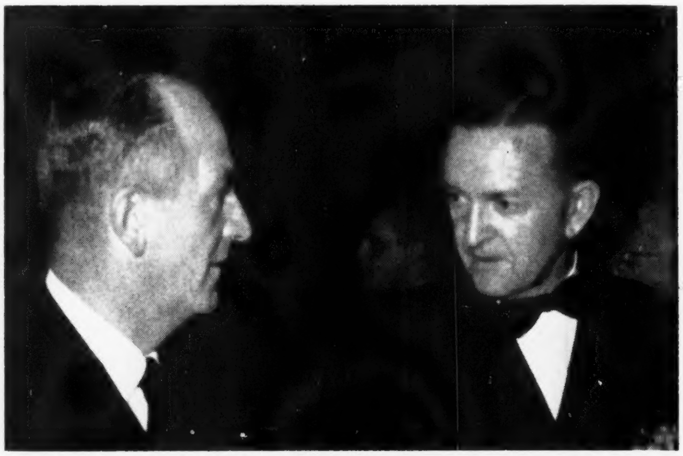


Max A. Lowy William F. Hurst

Banquet speaker will be Rear Adm. B. Van Mater, vice-chairman, U. S. National Committee for IGY. His topic will be "Telemetry and the IGY." Luncheon speakers will discuss telemetry in the Air Force and Navy.

Those wishing to submit abstracts or manuscripts for consideration by the committee should send them to Mr. Lowy, Mr. Hurst or Mr. Harford at the ARS office, 500 Fifth Ave., New York 36, N. Y., not later than Jan. 6, 1958.

Navy Men Get Together



Adm. John H. Sides (right), featured speaker at recent joint ARS-IAS meeting in New York, chats with another Navy man, Capt. H. O. Hauck, at the meeting.

Seven More Companies Become ARS Members

Seven more companies active in the rocket, guided missile or jet propulsion fields have become corporate members of the American Rocket Society. They are:

Radio Corp. of America (Defense Electronic Products), Camden, N. J., manufacturers of airborne electronic systems including, but not limited to, radar, communications, and ground and airborne control devices for all airborne equipment.

Representing the company in ARS activities will be F. L. Ankenbrandt, manager, defense products; A. N. Curtiss, manager, West Coast Electronic Products Dept.; Jack Frailey, manager, systems projects; David Shore, manager, systems engineering; and A. W. Vance, chief systems engineer, systems engineering.

J. H. Day Co. Div. of Cleveland Automatic Machine Co., Cincinnati, Ohio, manufacturer of dispersion, mixing, sifting and milling equipment for many processing industries and dispersion mixing equipment for solid propellants.

Named to represent the company in ARS are Harold LeBlond, president, Cleveland Automatic Machine Co.; Martin Miller, vice-president, Cleveland, and general manager, J. H. Day Co. Div.; Jack Diltz, sales engineer; Ray Allison, chief engineer, J. H. Day Co. Div.; and John Prohaska, vice-president and sales manager, Cleveland Automatic Machine Co.

Ford Instrument Co., Division of Sperry Rand Corp., Long Island City, N. Y., active in development, design and manufacture of guidance systems and their components, launching order computers and ground control equipment for missiles.

Representing the company in ARS will be Charles S. Rockwell, president and general manager; Lawrence S. Brown, manager, Missile Development Div.; William F. Weber, manager, Army contracts; Lewis J. Scheuer, engineering director, Missile Development Div.; and Charles S. Burrows, vice-president for engineering.

Shell Development Co., New York, N. Y., active in research and development work on rocket fuels.

Individuals designated to represent the company in ARS are A. J. Johnson, vice-president, development and engineering; T. W. Evans, vice-president, research; C. L. Dunn, head, development department; A. G. Cattaneo, head, research department; and D. M. Sheldon, secretary.

Grumman Aircraft Engineering Corp., Bethpage, N. Y., active in the field of tactical and strategic weapon systems employing rocket and or jet propulsion components.

Representing the company in ARS will be Ira G. Hedrick, chief technical engineer; Richard Hutton, chief engineer; Walter Scott, chief, preliminary design; Stuart Harvie, chief, propulsion department; and Oscar Erlandsen, director of missile development.

Coleman Engineering Co., Los Angeles, Calif., active in the design, construction and testing of high-speed track vehicles, as well as testing and

development of new rocket motors for use in track testing.

Representing the company in the ARS will be H. H. Clark, technical director; D. K. Dunbar, propulsion engineer; W. H. Brightman, ordnance specialist; J. L. Murphy, supervisor, rocket sled design; and J. E. Auck, supervisor, field operations.

Aeroquip Corp., Jackson, Mich., supplier of missile components and components for fuel loading.

Named to represent the company in ARS activities are Kent R. Manning, vice-president and general manager, Jackson Div.; John C. Abbey, chief engineer; Theodore J. Josalle Jr., aircraft sales manager, Marman Div.; William M. Willis, engineering manager, Marman Div.; and Edward S. Clark, chief engineer, Western Div.

SECTION NOTES

Columbus: Fred Bagby, chief, Aeronautics and Thermodynamics Div., Battelle Memorial Institute, was the guest speaker at the second fall meeting of the Columbus Section, attended by 46 members and guests.

Mr. Bagby presented a very interesting talk on "Environmental Testing of Missiles and Missile Materials." He described various methods used for testing materials, emphasizing the need for simulating simultaneously such variables as temperature, time, heat flux, chemical conditions and viscous forces. He also discussed the application of rocket motors as laboratory tools and mentioned the difficulties involved in instrumentation of materials tested in such devices.

Detroit: The first meeting of the new season for the Detroit Section was opened by Lovell Lawrence, Chrysler Corp. Missile Operations, newly elected president, at the Engineering Society of Detroit in the Rackham Memorial Building.

Mr. Lawrence introduced the officers and board for the coming year and outlined the Section program for the months to come.

The guest speaker of the evening, B. T. Stanaitis, supervising engineer of the Structures Laboratory's High Temperature Group at Chrysler Missile Operations, was introduced by Program Chairman L. B. Forman.

In his talk on "Simulated Re-entry Testing of Guided Missile Structures," Mr. Stanaitis pointed out that simulated re-entry testing is a relatively new field of activity brought about by the continually increasing ranges and velocities of guided missiles. Increasing vehicle size and complexity, with associated increase in expense, demand maximum utilization of available units. This increasing complexity is also reflected in the exceedingly high cost of missile flight tests.

He also stated that minimizing program costs while obtaining a maximum amount of data necessitates extensive pre-flight qualification testing prior to the first flight test of a new re-entry vehicle. The severity of re-entry thermal environments makes it mandatory to include high-temperature structural testing in pre-flight laboratory qualification testing.

Added to the disadvantage of high costs for flight tests is the limitation on the number and accuracy of available channels for transmitting flight information from the missile back to the ground. Lab testing permits more accurate measurements and permits subsequent utilization of prototypes for further tests. This facilitates spotting of problem areas that would be difficult to detect from flight test data.

A film shown by Mr. Stanaitis explained the employment of the different techniques used in laboratory re-entry testing.

North Texas: "Space travel will not be held back by lack of an adequate self-contained navigation system. Significant changes and im-

At Joint ARS-IAS Meeting in New York

Seated at the dais at the joint meeting of the New York ARS and IAS Sections are (left to right): Robert R. Dexter, IAS Secretary; Robert L. Gustafson, Grumman Aircraft Engineering Corp.; Adm. John H. Sides, guest speaker; G. Edward Pendray; Robert A. Gross, Fairchild Engine Div., President, ARS New York Section; S. Paul Johnston, IAS Director; Charles W. Faas Jr., Fairchild Stratos Div., Chairman, IAS New York Section; and James J. Harford, ARS Executive Secretary. Attendance at the meeting topped the 300 mark.

Georgia Tech Chapter on Redstone Tour

Members of the Georgia Tech Student Chapter are shown on a recent visit to Redstone Arsenal, Huntsville, Ala. In the course of the tour, the group witnessed a static firing of the Jupiter missile, flight firing of a ripple of 4.5 in. rockets and a static demonstration of a Nike installation.

on the calendar

Dec. 1–6	Annual Meeting, ASME, New York, N. Y.
Dec. 2–5	**American Rocket Society 12th Annual Meeting, Hotel Statler, New York, N. Y.**
Dec. 3–4	Joint Symposium, IRE and Human Factors Society of America, Penn-Sherwood Hotel, Philadelphia, Pa.
Dec. 5–6	Twelfth Annual Industrial Productivity Conference, Illinois Institute of Technology, Chicago.
Dec. 6	**American Rocket Society Eastern Regional Student Conference, Hotel Statler, New York, N. Y.**
Dec. 8–11	Annual Meeting, AIChE, Chicago, Ill.
Dec. 16–20	American Management Assn. Research and Development Seminar, "Capitalizing on Creativity in R&D," Sheraton-Astor Hotel, New York, N.Y.
Dec. 17	Wright Brothers Lecture, IAS, Washington, D. C.
Dec. 17–19	Conference on Nuclear Sizes, American Physical Society on West Coast, Stanford University, Palo Alto, Calif.
Dec. 19–21	Winter Meeting, American Physical Society on West Coast, Stanford University, Palo Alto, Calif.
Dec. 26–31	Annual Meeting, American Assn. for the Advancement of Science, Indianapolis, Ind.
1958	
Jan. 14–15	Yankee Instrument Fair and Symposium, sponsored by Instrument Society of America, Hotel Bradford, Boston, Mass.
Feb. 4–6	Thirteenth Annual Technical and Management Conference, Reinforced Plastics Div., The Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago.
Feb. 26–27	Air Force Assn.'s Third Annual Jet Age Conference and Guided Missile Symposium, Washington, D.C.
March 16–21	1958 Nuclear Congress, Chicago, Ill.
March 17–20	**American Rocket Society—ASME Aviation Div. Conference, Statler-Hilton Hotel, Dallas, Tex.**
March 17–21	Fourth Nuclear Engineering and Science Conference, Chicago International Amphitheatre, Ill.
March 18–19	Inter-Service and Industry Symposium on Guided Missile Training Equipment, Naval Ordnance Lab., White Oak, Silver Spring, Md.
June 2–4	**National Telemetering Conference under auspices of ARS, IAS, AIEE, ISA, Lord Baltimore Hotel, Baltimore, Md.**
June 9–11	**ARS Semi-Annual Meeting, Hotel Statler, Los Angeles, Calif.**
June 19–21	**Heat Transfer and Fluid Mechanics Institute Meeting, University of California, Berkeley.**
Sept. 15–18	**ARS Meeting, Hotel Statler, Detroit, Mich.**
Dec. 1–5	**ARS 13th Annual Meeting, New York, N. Y.**

provements in the art of navigation have been made over the past 10 years, and inertial navigation, 'acceleration sensing', is the most recent addition to the navigation engineer's bag of tricks."

These observations by Thomas B. Gibbs, senior design engineer, Texas Instruments, Inc., opened the Section's 1957–58 series of meetings at Arlington State College.

Section President George Craig, project systems installation engineer, Convair-Fort Worth, reported on plans for the Spring Meeting of ARS-ASME to be held next March at the Statler-Hilton Hotel in Dallas. Nominations for 1958 Section officers were made and minor changes in the Section's by-laws discussed in the short business meeting which preceded the interesting talk by Mr. Gibbs.

Mr. Craig reported that the outlook for the Section was promising, and outlined topics to be discussed at future meetings.

Sacramento: Approximately 60 members and guests attended a recent classified dinner meeting of the Sacramento Section, presided over by Section President Dan Tenenbaum. The guest speaker, Walter Beckwith, assistant senior engineer, Aerojet-General Corp., Azusa, was introduced by Program Chairman Harry York. Mr. Beckwith presented a stimulating discussion, accompanied by illustrations, of an advanced type of rocket propulsion system now under development by his group which is suitable for both guided missiles and manned aircraft.

STUDENT CHAPTERS

Parks College: Martin J. Lanfranco has been elected president of the Parks College (St. Louis University) Student Chapter for the coming year. Other new officers are Robert B. Karp, vice-president; Thomas B. Dennis, secretary; and Reginangelo DiPilla, treasurer. Faculty moderator is Peter W. Soule.

Seminar on Creativity In R&D Set for Dec. 16-20

The Research and Development Div. of the American Management Assn. will hold a seminar on the subject of "Capitalizing on Creativity in R&D" at the Sheraton-Astor Hotel in New York City Dec. 16–20. Discussions will center on the industrial setting for creativity, characteristics of creative people, creativity in the development of new products, creativity as an individual role and managing the creative man.

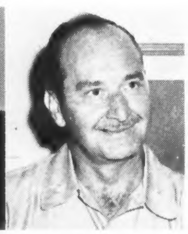
people in the news

APPOINTMENTS

David Eaton has been named to the new position of vice-president of marketing, **Delacey Ferris** to chief engineer and **Edward Seymour** to director of research at Reaction Motors, Inc. Eaton was previously vice-president for program management, while Ferris was manager of the Rocket Engine Projects Dept. and Dr. Seymour was manager of the Preliminary Design Dept.

Frederick H. Guterman has been appointed general manager of the Technical Products Div., Allen B. Du Mont Laboratories, Inc., and **William G. Fowler** has been named manager of technical products engineering for the company. Guterman was formerly assistant vice-president, sales and planning, American Bosch Arma Corp., and Fowler assistant engineering manager of Du Mont's Technical Products Div.

Robert H. Beachler Jr. has been appointed director of engineering for the Leach Corp. In his new post, Beachler, formerly director of the engineering research laboratory of North American Aviation, will also be responsible for management of the Leach Special Products Div.

Eaton **Steinkamp**

Lt. Col. George R. Steinkamp has become the second head of the Department of Space Medicine, AF School of Aviation Medicine, Randolph AFB, Tex., succeeding **Dr. Hubertus Strughold,** who has held down the post since founding the department in 1949. Dr. Steinkamp, whose specialty is human survival in unusual environments, has been assigned to AF headquarters in Washington for the past year. Dr. Strughold will become advisor for research to the School Commandant, Maj. Gen. Otis O. Benson Jr.

Clary Dynamics, a division of Clary Corp., has named **Frank G. Denison** to the post of director of research and development and **John D. McKenney** to chief engineer of the research and development section. Both were formerly with Jet Propulsion Laboratory, Denison as chief of the design and development section and McKenney as chief of industrial planning.

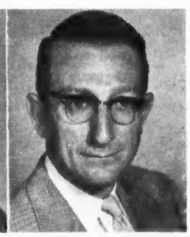
George F. Rice has been appointed chief engineer of Garrett Corp.'s AiResearch Aviation Service Co. Rice was formerly chief engineer of Century Engineers, Inc., which he helped form in 1949 for missile and weapon development work.


Anselm **Muhleisen**

Beech Aircraft Corp. has appointed **R. Harvey Anselm** to the post of manager of the Missile Engineering Div. He has been with Beech for the past three years and prior to that was with Radioplane Co. as administrative and field test director.

Edward H. Muhleisen has been appointed manager, aircraft and missile industry activities, Fischer & Porter Co.

International Business Machines Corp. has appointed **Robert P. Crago** as director of engineering for its Military Products Div. and **Horace W. Thue** as director of manufacturing planning for the company. Crago was formerly general manager of the division's plant at Kingston, N. Y., while Thue was manager of the Missile and Commercial Aircraft Div. of Douglas Aircraft Co.

Crago **Chambers**

Robert W. Graham has been named systems sales engineer for Midwestern Instruments, Inc. He was formerly manager of the data processing equipment engineering operation of General Electric Co. in Philadelphia, Pa.

Maj. James E. Hughes has been named AF development field representative at Bell Telephone Laboratories, Inc., Whippany, N. J., laboratory.

Appointment of **Herbert I. Chambers** as chief development engineer has been announced by Consolidated Electrodynamics Corp. He was formerly assistant chief development engineer.

Lester A. Wells, former president and general manager of Engineering & Research Corp., has been named executive vice-president of Thieblot Aircraft Co., a division of Vitrox Corp. of America.

Four research scientists have been promoted to managers in the Government and Industrial Div., Philco Corp. The new managers, with their fields of research, are **F. J. Bingley,** audio-video data systems; **J. Forrest Bigelow,** radar and radio systems; **C. P. Woodward,** missiles and advanced tactical systems; and **Ralph Deutsch,** fundamental techniques.


Bingley **Bigelow**


Woodward **Deutsch**

Lt. Col. John H. Savage has been named Chief of the Ballistic Missile Office of the U.S. Army Ordnance District, Los Angeles, Calif. Col. Savage had been serving as Missile Production Officer of the District.

Jobe Jenkins has been appointed manager of the communications department for a weapons system technical division at Lockheed's Missile Systems Div. Dr. Jenkins was previously a staff scientist in the preliminary design department of the division's Palo Alto, Calif., research and development laboratories.

Flanigen **Greenup**

Geoffrey Keller has been appointed program director for astronomy in the Division of Mathematical, Physical and Engineering Sciences and **Walter J. Peterson** program director for special projects in scientific education in the Division of Scientific Personnel and Education of the National Science Foundation.

Five engineers have been named to the senior technical staff of Control Data Corp. They are **William R. Keye,** who will serve as associate director of engineering, **Robert N. Kisch, Robert L. Perkins, Howard Shekels** and **Seymour R. Cray.**

C. Douglas Flanigen has been appointed chief engineer of the Lycoming Div., Avco Mfg. Corp. Before joining Lycoming, Flanigen was a consultant engineer on design and marketing of missile and aircraft components.

Appointment of **Francis T. Greenup** as chief product engineer has been announced by Consolidated Electrodynamics Corp. Greenup was formerly assistant chief product engineer.

George M. Russell has joined Packard-Bell Electronics as liaison engineer attached to the Washington, D. C. office. Russell was formerly with RCA Service Co., Inc., where he was engaged in systems engineering at Patrick AFB, Fla.

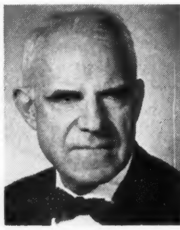
 

Russell **Coffin**

Joseph W. Lewis has been appointed assistant to the president of Beckman Instruments, Inc. For the past six years, Lewis has been manager of Arnold O. Beckman, Inc.

David D. Coffin, manager, Missile Systems Div., and **Thomas H. Johnson,** manager, Research Div., have been elected vice-presidents of Raytheon Mfg. Co. Coffin has been manager of the Missile Systems Div. since 1951, while Dr. Johnson joined the company in October after six years as director of the AEC research program in the physical sciences.

Bendix Aviation Corp. has named **R. J. Creagan** to head its nuclear program. Dr. Creagan was formerly with Westinghouse Electric Corp. as manager of the company's Reactor Engineering Dept. for commercial power activities.

Johnson **Perino**

P. R. Perino has joined Allegany Instrument Co. as a project engineer. He was formerly head of instrument engineering for Aerojet-General Corp., Sacramento, Calif.

Francis L. Scott has been named project leader in Pennsalt Chemical Corp.'s Technical Div., where he will conduct basic research in organic nitrogen chemistry.

Harold S. Goldberg has joined Consolidated Avionics Corp. as chief development engineer. He was formerly with Emerson Radio & Phonograph Corp.

HONORS

Col. John P. Stapp, chief, Aero Medical Field Laboratory, Holloman AFB, N. M., has received the Gorgas Medal for distinguished service in military medicine. Col. Stapp was honored at the annual dinner of the Assn. of Military Surgeons for his work on rocket sleds.

Wernher von Braun, director, Development Operations Div., Army Ballistic Missile Agency, Huntsville, Ala., has received the nation's highest civilian award—the Exceptional Civilian Service Award—for his part in the creation of the Army's Jupiter IRBM. **Maj. Gen. John B. Medaris,** Commander of ABMA, where Jupiter was developed, has been awarded an Oak Leaf Cluster to the Legion of Merit by the Army.

Donald A. Quarles, Deputy Secretary of Defense, recently received the American Institute of Consulting Engineers Award of Merit for 1957. The award, citing him as "an able administrator and noted scientist," praised Mr. Quarles for his "outstanding example of how scientific training, broad technical experience and conscientious endeavor can be combined successfully to meet the demands of enlightened government in a free economy."

Arthur E. Raymond, vice-president for engineering, Douglas Aircraft Co., will receive the 1957 Daniel Guggenheim medal "for notable achievement in the advancement of aeronautics" in New York on Jan. 28. Raymond, with Douglas since 1925, has been its engineering head since 1936.

Lewis W. Imm (left), president of Librascope, Inc., is shown receiving the highest Navy civilian citation for his contribution to naval ordnance and fire control techniques. Presenting the Navy Distinguished Service award and gold medal is Rear Adm. Grover B. H. Hall, Commander Naval Air Bases, 11th and 12th Naval Districts.

The U. S. Junior Chamber of Commerce has nominated **S. Fred Singer,** associate professor, department of physics, University of Maryland, and well-known astrophysicist, to receive one of its 10 "Outstanding Young Men" awards. The awards will be presented at a banquet.

Clifford C. Furnas, Chancellor of the University of Buffalo, Buffalo, N. Y., and former Assistant Secretary of Defense for Research and Development, and **James H. Doolittle,** vice-president of Shell Oil Co. and aeronautical pioneer, were recently conferred honorary degrees in engineering by the University of Michigan.

Among the 34 "distinguished alumni" of the University of Michigan College of Engineering cited for outstanding engineering achievements at dedication ceremonies for the University's new Automotive and Aeronautical Engineering Laboratories were **Carl Haddon,** chief engineer, Lockheed Aircraft Corp.; **William Parker,** manager, weapon system design, Missile Development Div., North American Aviation, Inc.; **Oswald Schaefer,** manager, Quality Control Dept., The Martin Co.; **Philip Brice,** chief engineer, Republic Aviation Corp.; **Leo A. Weiss,** Avien, Inc.; and **Commander Robert Freitag,** Office of the Chief of Naval Operations, Ballistic Missile Branch.

Space Flight

(CONTINUED FROM PAGE 44)

very-long-range ballistic vehicles, stressing those quantitative ideas which are uniquely related to space flight, and avoiding sensational and "space cadet" type of material. The course is planned for those engineers, physicists, mathematicians, astronomers and others interested and concerned with space technology. The outline on page 45 indicates the scope of the course.

The roster of lecturers is a distinguished one. It includes 18 research administrators, of whom six bear the title of laboratory director, and 14 full professors, of whom four are heads of departments of physics or engineering. There are 12 speakers who have published or are about to publish books on their specialties. Six of the lecturers have important responsibilities for the IGY effort. A number hold several of these positions simultaneously. They represent a broad cross section of American scientific life, including five major universities, seven large industrial organizations and seven principal government research laboratories.

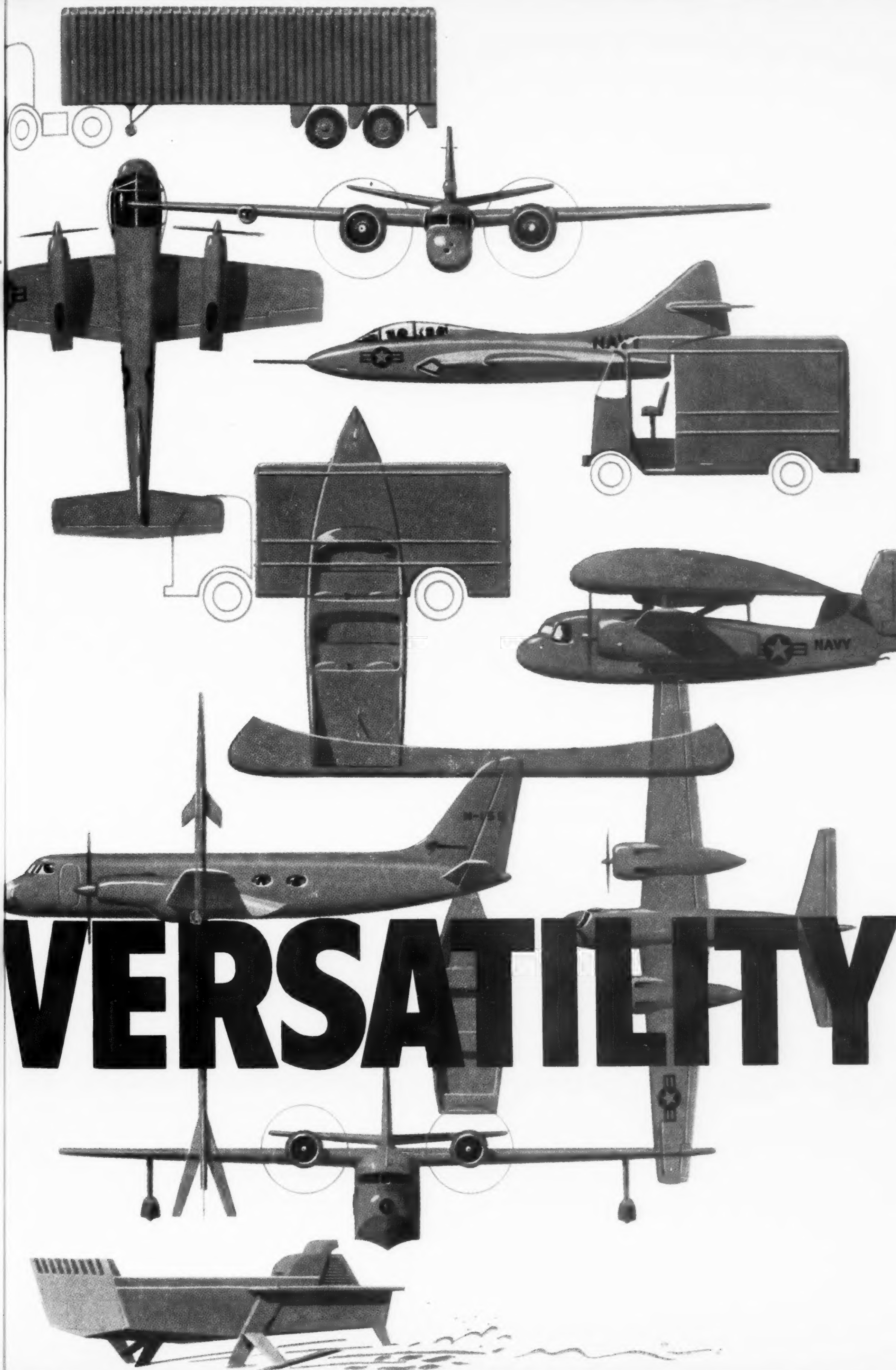
It is anticipated, therefore, that the fruits of the labors of such a competent array of men will be a major contribution to the technology of space travel, one which will codify the significant laws and point out significant problems for the inspiration and guidance of the enormous development effort yet to come.

Anyone wishing information concerning the course may write to John C. Dillon, Head, Engineering Extension, University of California, Los Angeles 24, Calif.

Overtime Authorized In Missile Programs

The recent memorandum from newly appointed Secretary of Defense Neil H. McElroy calling for weekly progress reports on Army, Navy and Air Force missile programs also noted that all requests for permission to utilize overtime in such programs had been approved.

"I am not aware of any regulations that have been imposed which are presently hampering our efforts to carry out . . . schedules," the memorandum continued. "It is apparent, however, that we should give continuing attention to the removal or modification of any regulations which could conceivably impede progress in these fields."



VERSATILITY

Suite 304, the Ritz

(CONTINUED FROM PAGE 47)

of the existence and purpose of the IAF.

In this atmosphere and mood, I was elected President for the ensuing year. My only comment to the delegates was that they had voted for me not from their brains, but from their hearts. Vice-presidents elected were A. Hjertstrand, Sweden; J. M. J. Kooy, Holland; Leonid I. Sedov, U.S.S.R.; L. R. Shepherd, Great Britain; Teofilo M. Tabanera, Argentina; and K. Zarankiewicz, Poland.

The resolution concerning the revision of the IAF Constitution provided for creation of "an ad hoc committee consisting of six members who will be nominated and elected by the Member Societies, and one of whom shall be designated as Chairman by the President, which will be known as the Committee on the Correction and Revision of the Constitution. Each Member Society shall submit to the President on or before Jan. 31, 1958, its recommendations for the correction and revision of the Constitution. Each such recommendation shall be considered and finally disposed of by the Committee, and brief reasons shall be given for every such action. The Committee may take final actions by majority votes of a quorum of the membership thereof, and a quorum shall consist of three members of the Committee. The President shall be an ex-officio member of the Committee and his presence at a meeting shall be counted in reaching a quorum.

"The Committee shall meet *in persona* within 150 days from Jan. 31, 1958, and it shall submit to the President before the next Congress a corrected and revised Constitution with brief statements of reasons for each such correction and revision. The President shall submit said report to qualified Swiss legal counsel for his opinion as to the legality of the corrected and revised Constitution, and all pertinent documents will thereupon be duplicated and submitted to the Member Societies for further consideration."

The Committee appointed by outgoing President Leslie R. Shepherd of Great Britain consists of myself as chairman; Fritz Gerlach, Germany; Alla T. Masevitch, U.S.S.R.; Georges Delval, France; L. J. Carter, England; and Joseph Stemmer, Switzerland.

In view of the legal complications and involvements which are bound to arise as the result of ventures into space above the earth's atmosphere, I suggested the creation of a Committee "to define the regions of jurisdiction of air law, and of space law." By common consent, John Cobb Cooper, general counsel of the International Air Transport Association and world-renowned international lawyer, was named chairman of the committee, which has been designated the "Cooper Committee." The committee will submit its findings and recommendations to the Secretary-General of the United Nations.

Dr. Shepherd suggested that no persons other than Prof. Cooper, with the exception of A. F. Spilhaus, Dean of the Institute of Technology, University of Minnesota, should be appointed to the committee at this time. This was agreed to, and it was also agreed that Dr. Sedov would arrange for the appointment of two Soviet scientists to the Committee. It was also felt that the U. S. should be limited to two members and the U.S.S.R. to two members, with the rest of the Committee coming from other countries.

It was the general consensus of the Congress that the Cooper Committee, in addition to defining air jurisdiction and space jurisdiction as an adjective task, should also undertake the substantive task of stating jurisdictional rules.

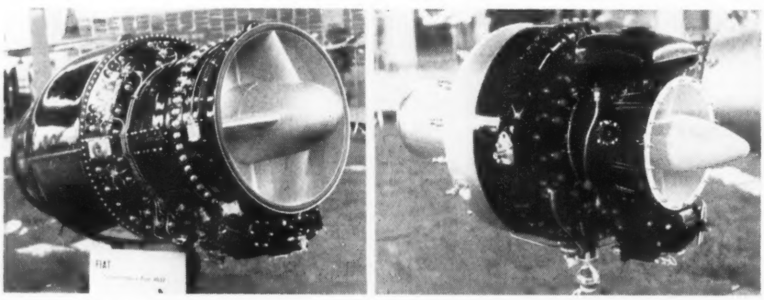
Springer to Reprint Papers

W. Schwabl of Springer-Verlag discussed *Astronautica Acta* and announced that Springer would print the papers delivered at the 8th IAF Congress. Friedrich Hecht was continued in office as chairman of the *Astronautica Acta* Committee, which is also the committee which finally passes upon papers to be delivered at the Congress. Prof. Hecht was authorized by Dr. Shepherd to name the other members of his Committee. During the Congress, Prof. Hecht named, in addition to himself as chairman, Dr. Klemperer as vice-chairman, and Dr. Shepherd, Dr. Eugen Sänger and Dr. Sedov to the committee. Any paper to be delivered at the 9th Congress in Holland next year must be approved in writing by one of these committee members. This, of course, in no way impinges upon the authority of any member society to screen the papers initially in its own right.

The present Screening Committee for the American Rocket Society consists of Krafft Ehricke, Dr. Singer and Werhner von Braun. The creation of the ARS Screening Committee is, of course, within the competence of the President of the ARS, and not the IAF.

A new Finance Committee was constituted, with Georges Delval of France taking my place. The Nominations Committee will consist of persons named from the member societies from the U.S.S.R., Yugoslavia, Holland, Argentina and Spain. The Credentials Committee will continue to be headed by Fritz Gerlach of Germany. Fred Durant is the new chairman of the International Affairs Committee.

As noted above, the 9th IAF Congress will be held in Amsterdam or The Hague the week commencing Aug. 25, 1958. No final proposal is on hand for the 10th Congress. Dr.



The new Fiat Model 4032 (left) and Model 4002-01 turbojet engines.

Two New Italian Turbojets

Fiat recently showed two new turbojet engines, Model 4002-01 and 4032. The former is a centrifugal engine with a single-stage compressor, annular combustion chamber and single-stage turbine. It has a static thrust of 716 lb with a specific consumption of 1.21 lb/lb/h.

Model 4032 is brand new, having made its bow in October. It has a nine-stage axial compressor, an annular chamber and a single-stage turbine. The only specifications released to date are: Thrust, 6600 lb, and dry weight, 1100 lb.

Sedov has tentatively suggested Moscow as the host city, but he must ascertain whether such arrangements can be made and will report the official Soviet action within two or three months. If Moscow is unavailable, the 10th Congress will be held in London. In 1960, the 11th Congress will be held in Stockholm. This is a firm commitment. It was suggested that in 1961 the 12th Congress be held in Washington, D. C. The ARS delegation made it clear, however, that approval of the board of directors of the ARS must be obtained before any final action may be taken.

Salute to Col. John P. Stapp

At Barcelona, when Sputnik glowed so brightly that it nearly extinguished our pride, we could always muster Col. John P. Stapp to assuage our battered feelings. When Khrushchev was quoted as stating that his scientists never talk about anything until they have done it, we could retort that in the person of Col. Stapp and in the fine officers attached to his group, such as Maj. Simons and Capt. Joe Kittinger, we had human beings, not dogs, who were personally challenging the physiological problems of space travel.

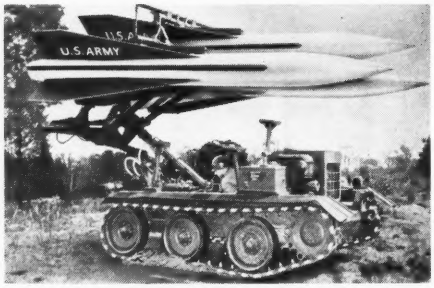
American delegates like Dr. von Kármán could reminisce on the early concepts of the high-speed sled experiments undertaken by him with Jack Northrop, and on the notable progress and evolution of these experiments through the memorable and heroic experiments of Col. Stapp himself. We could point out the highly technical and very successful long-duration tests designed to determine man's ability to withstand extremely high altitudes, performed under the direction of Col. Stapp by Capt. Kittinger and Maj. Simons.

John Paul Stapp was born in Bahia, Brazil, 47 years ago. He has a Ph.D. from Texas and an M.D. from Minnesota. He specializes in biophysics and is a pioneer in aeromedicine. In the latter field, he has made outstanding contributions in such areas as aviation medicine, high-altitude flight, crashing, ditching, impact injury and industrial medicine.

Defense Dept. R & E Post Goes to J. R. Townsend

John R. Townsend has been appointed special assistant to the Assistant Secretary of Defense for research and engineering. Mr. Townsend, formerly director of materials and standards engineering for Sandia Corp., will also serve as Director of the Office of Fuels, Materials and Ordnance.

Hawk Eyes—and Feet



Raytheon recently pulled back the security cover just far enough to reveal that its Hawk surface-to-air missile is using a "radically advanced" radar guidance system. The Hawk system (left), says the company, is able to pick out the reflection of a moving, low-altitude target from the mass of reflections caused by stationary ground objects such as hills, buildings and tree tops.

Speed and mobility of operation of the Hawk system is provided by a new tractor-driven loader (right), which makes it possible to quickly transfer three birds from the storage area to the launcher.

Filling the Gap

(CONTINUED FROM PAGE 29)

fast, with orbits too close to the earth, to be of much value to them and their particular research interests.

The authors of the satellite proposal, Elbert Eaton and Robert Slavin of the Special Projects Laboratory, did not suggest a specific propulsion system that is now available. But, with access to missile projects and from their experience in the field, they feel confident that such a propulsion system will be feasible within five years.

Their plans, in fact, call for the first "verifier" rockets to be launched in January, 1959. These flights will go to 4000 miles and above. Their purpose will be to verify conclusions obtained by the extrapolation of actual data collected at altitudes below 4000 miles. This data will come from past and present rocket firings, from the planned 300-to-1000-mile research rocket program mentioned above, and from piggyback instrument packages Eaton's group plans to hitch to long-range ballistic missile test vehicles. Once confirmed, this data will then be used in making detailed plans for the satellite firings which will follow.

If the Air Force okays the project and provides the necessary funds, Eaton plans to ally his group with the three AF ballistic missile programs and invite qualified satellite men throughout the U. S. to join AFCRC in the satellite program, irrespective of any affiliations with other branches of the military.

To keep costs to a minimum, Eaton will integrate all efforts as far as possible. Work on all capsules will proceed simultaneously under one roof. And, as Eaton sees it, there will be a great deal of scientific know-how and engineering that will be applicable to all three satellites.

The monatomic ramjet, although technically a SPL project, is actually being carried out under contract by Paul Harteck at Rensselaer Polytechnic Institute. And, unlike the new sounding rocket and satellite projects, it is connected with the work of only one of the nine SPL laboratories, the Photochemistry Laboratory under Murray Zelikoff.

Dr. Harteck hit upon the idea of using atomic oxygen to propel a vehicle about five years ago. The AF first sponsored his work through its Office of Scientific Research. Then, as the project developed, it began to tie in more and more with work that AFCRC was doing in the chemical physics of the upper atmosphere, so SPL took over sponsorship.

In October, 1955, Dr. Zelikoff's group demonstrated the fact that solar energy was stored in the upper atmosphere in the form of ions, radicals and atoms. They also showed that the release of this stored energy could be accelerated by the introduction of a catalyst into the region. To demonstrate this, the group used an Aerobee rocket which released sodium vapor at the desired altitudes.

The first release of stored solar energy from atomic oxygen took place in March of the following year. In this experiment, the scientists used nitric oxide, which was released from an Aerobee-Hi at an altitude of 63 miles. In effect, this reaction consisted of the recombination of two atoms of oxygen into molecular oxygen with the release of energy in the form of light and the recovery of the nitric oxide unchanged.

The next step, as far as Dr. Harteck is concerned, is the development of a vehicle which can use this free atomic oxygen as fuel. Such a vehicle has already been designed, and, according to Dr. Zelikoff, the first prototype is expected to be flying in about a year.

Present prototype plans call for a cylinder with an opening of one square yard. The inside surface of the cylinder will be coated with a solid catalyst. Atomic oxygen entering the vehicle will recombine on the inner surface with the release of heat. The incoming air, thus heated, will move out of the rear end of the vehicle at a velocity greater than that with which it entered, imparting thrust to the vehicle.

Actual thrust is expected to be comparatively small even for the full-scale vehicle, and so the ramjet will have to be correspondingly light in weight. At the same time, the vehicle will have to be large enough in cross section to permit the required large amounts of air with its atomic oxygen to pass through. As a result, says Dr. Zelikoff, the chances of making a manned craft out of it do not look very promising at present.

Useful as Research Station

Nevertheless, AFCRC scientists are very much interested in the vehicle as a possible unmanned research station. It would produce enough thrust to overcome drag but would not have to operate in a fixed, high-speed orbit. The fuel supply would be inexhaustible, and the catalyst, theoretically at least, would last indefinitely. Use of the craft, of course, would be restricted to the atomic oxygen layer of the atmosphere, a region from about 50 to 70 miles above the earth.

In operation, the ramjet will be launched in a manner somewhat similar to that of a satellite. This means that it will probably be collapsible, so it can fit inside a rocket nose cone. Its speed will be in the Mach 3–4 region. Launching and operation of the vehicle will be under the direction of AFCRC.

Spectacular as these projects may first seem, they are not the results of any undisciplined rush by the Air Force to regain headline space from the Russians. Rather, they are the orderly outgrowth of upper air research programs in progress for some time at AFCRC. And, placed in their proper perspective, they actually represent but a small part of the work actually under way here.

in print

Rockets, Missiles and Space Travel (Revised Edition) by Willy Ley, Viking Press, New York, 1957, 544 pp., illustrated. $6.75.

Reviewed by Wernher von Braun
Army Ballistic Missile Agency.

Willy Ley has scored again with this revised edition of "Rockets, Missiles and Space Travel," and, as usual, has come up with a tome that will warm the hearts of rocket men, space travel enthusiasts and collectors of Ley books.

This revised edition assures him a niche in the annals of rocketry as the "Good Gray Chronicler of Rocket Lore," if indeed he did not already hold this title. To readers and collectors of such lore, his books are like old friends. Fortunately, Ley has not succumbed to the usually fatal occupational disease which is so widespread among historians—dullness. Without sacrificing scholarship, Ley commands a style which makes what might otherwise be dull facts come to life. He will undoubtedly remain the authoritative popular historian of rocketry.

Ley wrote his book before "Sputnik" was orbiting our planet. Concerning man-made satellites, Ley writes: "It would not surprise me too much if somebody in the future tried to make out a case that during the years 1953 and 1954 a number of 'space-happy' scientists (to use a term coined by Robert A. Heinlein) carried out a conspiracy to talk their government out of tax money for their wild schemes. Scientific institutions, public lecture halls, the magazines, the newspapers, the radio waves, and the television channels were full of space travel and satellite talk. To discourage a possible future compiler of such a story at the very outset I can tell him that it all more or less just happened. The dozen or so men who talked space travel had talked space travel all their adult lives . . ." In view of recent satellite developments, Ley could have added, with justifiable sardonicism: "But nobody listened."

Ley's revised edition offers a wealth of new material. The story of the Peenemünde rocket research institute of the German Army has been completely rewritten in personal consultation with Walter Dornberger (V-2), other Peenemündians and this reviewer. Forty per cent of the book relates to the past, 40 per cent to the present and 20 per cent to the future.

There was an obvious need for Ley's revision. Concerning this need, Ley says: "Since then (1951) there have been six years of fast progress all along the line, from beautiful and detailed theoretical work in the space travel field to the practical development of whole 'families' of new rocket fuels. Obviously, the book had to keep up."

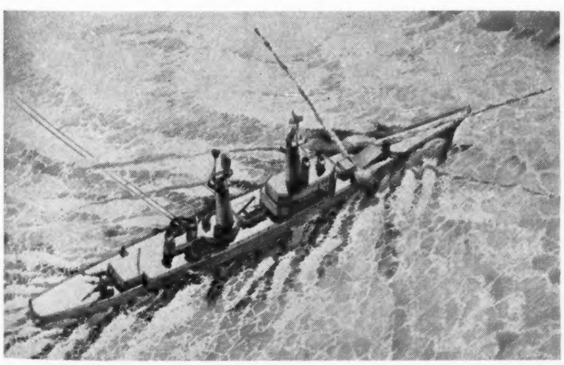
In keeping up, Ley has expanded his chapter on war rockets. As stated, he has completely rewritten the story of Peenemünde. The original framework of 12 chapters can be recognized, as can the two appendices and a bibliography, but few consecutive sentences remain the same. The White Sands Proving Ground chapter has been revised line by line. In former editions the "step" principle was chiefly a theoretical concept. The principle, which threaded the warp and woof of the old Chapter 10, still fulfills this function. In the revised chapter, however, it is a matter of facts and figures, take-off weights and firing dates.

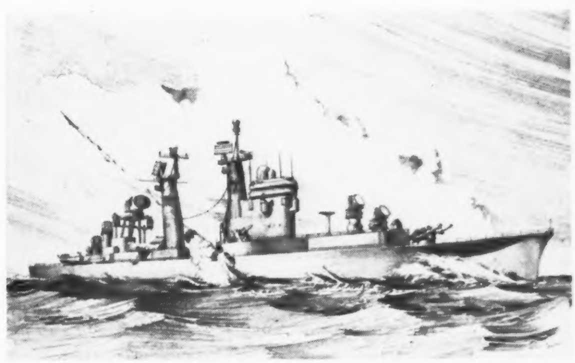
The space travel chapters have undergone the greatest change of all, because they reflect a change in attitude. As Ley says: "In 1951, the artificial satellite was something for which one still pleaded, something one tried to prove was both possible and useful." (Little Sputnik was not passing over us every 96 minutes and two seconds when Ley wrote these words.)

But the Soviet satellite is now a reality. Ley's space travel chapters point up the fact that the age of the microcosm is past. The age of the macrocosm has dawned, and Man's potential for even greater strides in the conquest of space staggers the imagination.

"In this current revision," Ley says, "there is still little 'future' left. The probability is high that during the next 12 years it, too, will move into 'present.'"

As the Good Gray Chronicler, Ley deserves his day in court. His opinions deserve careful and judicious consideration. Both professional rocket men and space aficionados will find "Rockets, Missiles, and Space Travel" a valuable addition to the growing bibliography of books on the subject of guided missiles and astronautics.





New Navy Profiles

Sketches show how the guided missile age is changing ship shapes. Latest conception of the guided missile frigate (left) shows launcher and guidance installations located fore and aft. Proposed conversion of a World War II cruiser (right) indicates replacement of conventional gun turrets by missile systems. Such changes, says the Navy, will significantly increase both the anti-aircraft and the anti-submarine potential of the ship and, consequently, the fleet.

Missile Training Equipment Symposium Set for March 18-19

The first Inter-Service and Industry Symposium on Guided Missile Training Equipment will be held at the Naval Ordnance Laboratory, White Oak, Silver Spring, Md., March 18-19. The meeting, sponsored by the Guided Missiles Div., Office of the Chief of Naval Operations, coordinated by the Naval Training Device Center and hosted by NOL, will review the state of the art and discuss the role of training equipment in determining and measuring the proficiency of service personnel in utilizing the missiles placed at their disposal.

Attendance at the meeting will be limited to persons possessing Secret clearance. Requests for information should be addressed to J. G. Vaeth, Head, New Weapons and Systems Div., Naval Training Device Center, Port Washington, L. I., N. Y.

Disney "Man in Space" Film Now Available

Walt Disney's "Man in Space" film is now available for private rental, as well as in a special school donation plan. To encourage business organizations to donate prints of the film to educational institutions for use in science instruction, a special lease fee is offered for an extended lease period of 10 years for each print donated to educational institutions.

In addition, a two-minute epilogue in which Disney encourages students to consider careers in engineering and science will be added to donated prints at no charge, and a credit title listing the donating company may be added at a nominal charge.

Running time for "Man in Space," a 16 mm sound film in color, is 35 min. Information concerning its availability may be obtained from Walt Disney Productions 16 mm Div. offices in New York City and Burbank, Calif.

Human Factors Group To Meet Dec. 3-4

A national symposium on "Human Factors in Systems Engineering" will be held Dec. 3-4 at the Penn-Sherwood Hotel in Philadelphia. The meeting, sponsored jointly by the Human Factors Society of America, the Philadelphia Section of the Institute of Radio Engineers and the Professional Group on Military Electronics of IRE, will include sessions on the engineering and human factors approaches to systems synthesis, as well as a panel discussion on designing the control system for a space ship.

Eyes on the Sky

(CONTINUED FROM PAGE 41)

The photographic technique should yield directions of the satellite from the tracking stations with a precision of about 10 m, or, conversely, to interpolate the positions of the stations with such accuracy. These measurements, the authors state, can be used according to two basic principles—triangulation (effective) and gravitational anomalies.

See Sputnik I Rocket Crashing This Month

Soviet and U. S. scientists believe the orbiting third stage of the Sputnik I launcher will fall to earth this month. This view has been expressed by both Prof. K. Stanyukovich, over Moscow radio, and by Fred L. Whipple, director of the Smithsonian Astrophysical Observatory.

Both experts also expressed the belief that part of the rocket, made out of heavier metal than Sputnik, might reach the earth. The flaming rocket should be visible by day, as well as at night, Dr. Whipple noted, adding that U. S. residents have a good chance of seeing it fall. He also said that Sputnik I, its radio voice now silent, should remain in orbit until the end of the year, or two weeks thereafter.

His estimates on the life of the rocket were based on calculations which showed that its orbit was growing shorter by one-third of a second on each circuit around the earth.

Photographic observation stations are now under construction at Organ Pass, White Sands, N. M., and West Palm Beach, Fla.; on the island of Maui, Hawaii; Mitaka, near Tokyo, Japan; Naini Tal, India; Shiraz, Iran; Cadiz, Spain; Santa Barbara, on the island of Curacao; Arequipa, Peru; Villa Dolores, Argentina; Johannesburg, South Africa; and Woomera Range, Australia.

As the authors point out, the success of the program depends to a large degree on the ability to determine the exact orbit and orbit variations by means of high speed computers. In addition, maintenance of an effective communications system to relay data to the computers is vital.

Toward the latter end, an elaborate communications network, centered on the Smithsonian Observatory, has been established. At present, normal commercial radio or cable channels seem to offer the best possibilities, with one prime and one alternate route selected to forestall communications breakdowns.

A regular communications schedule will be maintained between the Observatory and the 12 photographic stations, while Moonwatch teams will, wherever possible, report separately and individually to Cambridge after each satellite passage.

Upon receipt of observational data, which will already be in a form that can be fed directly into the computer, at Cambridge, the necessary calculations will be carried out by an IBM No. 704 calculator at MIT.

Will Yield Precise Values

The computative program is one of successive approximations which will eventually yield refined and more precise values of those parameters of the earth which are the basis for the theoretical aspects of geodesy, as well as information about atmospheric density.

In concluding their paper, the authors point out that there is a good possibility that a number of satellites will be launched during the IGY period, and that some of these may remain in orbit beyond the end of this period. Consequently, a need exists for expansion of the visual and optical tracking program and provision should be made for its continuation well into the future.

"The geodetic, atmospheric and astronomical results from the program," they comment, "will become accumulatively more significant with an increase in the number of observations and with extended observations of satellites in varying orbits.

"We can therefore . . . anticipate future satellites and more distant satellites until indeed it may some day come to pass that the distance from the earth to our natural satellite will be amply marked by the orbits of man-made moons."

ARS takes Manhattan

(CONTINUED FROM PAGE 22)

The New York Section will sponsor two social events during the meeting: A Luncheon to be addressed by OSR boss Brig. Gen. H. F. Gregory, and a film night. The latter will mark the ARS premiere of a Rocketdyne film called "Road to the Stars," a Thiokol film on solid propellant rocketry, and a series of Vanguard test films from The Martin Co. IBM's "A Moon is Born" is reportedly being revised as a result of the unexpected birth of "those other" moons, and should be ready for the occasion.

Announcement of the new officers and directors for 1958 will be one of the features of the Annual Business Meeting. This will also be the occasion for President Truax to report on the past year's activities, and for Treasurer Robert M. Lawrence of Reaction Motors to disclose the financial picture of the Society.

In the past, this meeting has also been the occasion for hearing Section ideas and gripes, and for giving the editors of ARS publications and the program committees opportunity to listen to the opinions and criticisms of members. This year it was decided to provide more time for these airings. Hence, a Section Delegates Conference, moderated by Membership Chairman John P. Stapp, will take place on Thursday afternoon, Dec. 5, after the Section Delegates Luncheon. Presidents of the Sections are being invited to come or send their representatives to both of these sessions.

Climax of the meeting, as usual, will be the Honors Night Dinner. No more timely speaker could have been invited than William M. Holaday, special assistant to the Secretary of Defense for Guided Missiles. This will be the first major address Mr. Holaday has made since assuming his post.

Other Awards to be Presented

At the Dinner, in addition to presentations of the Wyld, Pendray, and Hickman Awards mentioned earlier, the Robert H. Goddard Memorial Award will be given to Thomas F. Dixon of Rocketdyne; the ARS Astronautics Award will go to Krafft Ehricke; and the ARS Chrysler Award of $1,000 will be received by student award winner John Reece Roth, junior at M.I.T.

Fellow Members to be honored include three military men, one university professor, and three outstanding engineers from industry. They are Lt. Col. Langdon F. Ayres of the Air Force Ballistic Missile Div.; Maj. Gen. John B. Medaris of the Army Ballistic Missile Agency; Maj. David G. Simons of the Aero Medical Field Laboratory; S. Fred Singer of the University of Maryland; past ARS president Noah S. Davis of Food Machinery and Chemical Corp.; Henry L. Thackwell Jr., of Grand Central Rocket Co.; and John Tormey, Rocketdyne.

These awards and fellowships represent just one more significant con-

trast between 1957 and 1946. Eleven years ago there were no such honors given—presumably because there were few enough achievements to be recognized.

It leads one to wonder what honors will be presented 11 years from now—at the 1968 meeting. This is a time span which many ARS seers confidently state will produce manned orbital vehicles, lunar and cislunar satellites, payloads to Mars, perhaps even unmanned vehicles landing on the moon.

I hereby propose that the menu for the 1968 Honors Night Dinner include two bottles of 1957 vintage champagne at each table to toast achievements which this year's meeting will help get under way. See you all at the Statler.

Space Flight Seen as Tool For Measuring Social Change

The Anthropology Section of the New York Academy of Sciences sponsored a "Man-in-Space" Symposium late in October to discuss the use of the space flight concept as a tool for measuring social change.

Donald N. Michael, of Dunlap & Associates, Stamford, Conn., industrial research firm, pointed out that people are already responding to the man-in-space concept. He noted that before Sputnik very few people knew anything about Project Farside, but that after the Red satellite was launched, people responded to Farside news. Dr. Michael, a former physicist, stressed the importance of gaining "before-and-after" information on these people and learning who they are and who are those who have not responded.

Other speakers at the meeting were Prof. Harold D. Lasswell of Yale Law School, who discussed the various sociological problems involved in space travel, and Lawrence Frank, who mentioned the many cultural changes that the space flight concept has already brought.

AF Assn. to Hold Missile Symposium Feb. 26-27

The Air Force Assn.'s third annual Jet Age Conference will be held Feb. 26–27 in Washington, D. C., and will feature a guided missile symposium. The symposium will cover the entire missile spectrum, ranging from current operational weapons systems to space flight, and will also examine the relationship between conventional and unconventional weapons systems.

from the patent office

BY GEORGE F. McLAUGHLIN

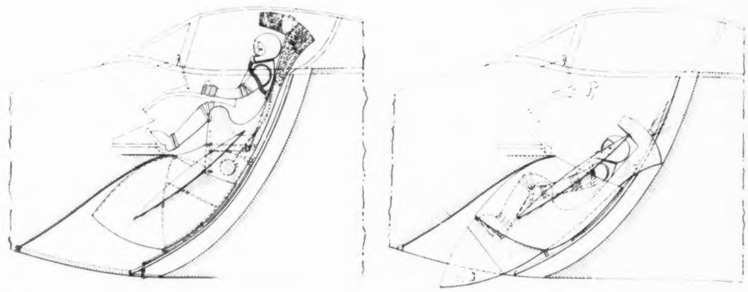
Ingenious Methods of Escape from High-Speed Aircraft

Two patents granted recently for downward ejection as a means of escape for pilots of jet aircraft are based on new and different concepts in construction and operation. Both aim to insure safe escape from disabled aircraft in pods that will clear the aircraft structure, using simple means that are positive in action. Emphasis was placed on devising pods that will be convenient, comfortable, and avoid complicated sequences of pre-ejection operations. The inventions require special cockpit arrangements as integrated components of the initial designs of the aircraft.

Patent 2,806,667 (Encapsuled ejection escape means for aircraft) granted to John Kugler, Inglewood, Calif., and assigned to Air Products Co., comprises a pod which may be released through a chute extending from top to bottom of the airplane body. Tracks guide the pod within the chute, which is curved so that the bottom opening is forward of the top. A hatch closing the bottom of the chute may be released by an explosive device.

The top of the pod contains a rocket and parachutes. The sides of the seat are enclosed, and a lower hollow extension has space for a survival kit and bail-out oxygen. At its bottom, the pod has a foam rubber shock absorber, streamlined to offer low resistance to movement of the pod from the chute.

The rocket, when triggered by a control, drives the pod downward into the enclosure and, together with the enclosure, through the chute opening and free of the aircraft. Stabilizer surfaces at both sides of the seat keep the pod from spinning and provide aerodynamic surfaces that serve as air supports when the pod is horizontal. The rocket propels the pod forward as well as downward. If the airplane is inverted, the stabilizer surfaces help move the pod up, rather than down, to bring it horizontal.



Pilot in normal flight position, and in the first stage of ejection from a jet-propelled pod forced forward and downward through a curved chute.

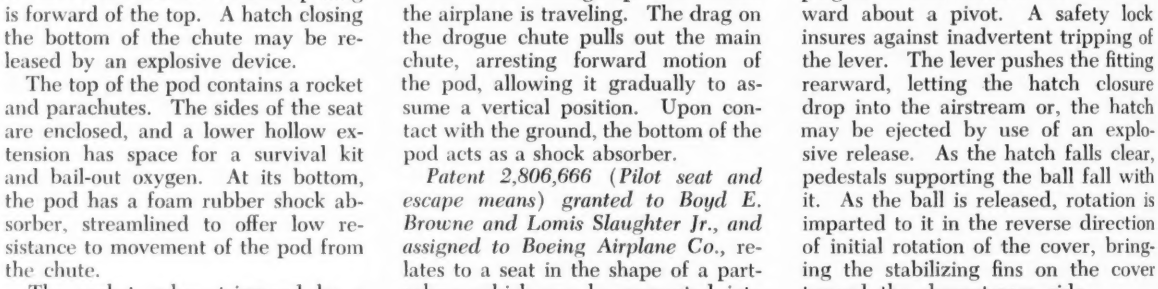
A timing mechanism may be used to release the drogue parachute stowed at the top of the seat. At this stage, the pod is clear of the plane but still has some of the high speed at which the airplane is traveling. The drag on the drogue chute pulls out the main chute, arresting forward motion of the pod, allowing it gradually to assume a vertical position. Upon contact with the ground, the bottom of the pod acts as a shock absorber.

Patent 2,806,666 (Pilot seat and escape means) granted to Boyd E. Browne and Lomis Slaughter Jr., and assigned to Boeing Airplane Co., relates to a seat in the shape of a part-sphere which can be converted into a ball before ejection. In normal flying position, the pilot, whose back is supported by an air cushion, is seated in the pressurized cockpit on a parachute pack within the inner shell of the ball, which is positioned in a nested position. In preparation for evacuating the airplane, he deflates the back rest and assumes a curled-up attitude, with his back against the inside of the inner shell. As he draws himself back, he grasps handles with each hand and pulls the pivoted shell part forward and downward, completely enclosing himself.

As the outer shell part completes the ball, a release cam strikes a tripping lever and deflects the ball forward about a pivot. A safety lock insures against inadvertent tripping of the lever. The lever pushes the fitting rearward, letting the hatch closure drop into the airstream or, the hatch may be ejected by use of an explosive release. As the hatch falls clear, pedestals supporting the ball fall with it. As the ball is released, rotation is imparted to it in the reverse direction of initial rotation of the cover, bringing the stabilizing fins on the cover toward the downstream side.

A window in the shell allows the pilot to determine when he has dropped far enough and is ready to bail out of the ball. To release himself from the ball, he pulls a ring, the two shell portions part at the pivoted connection, fall away from one another, and the pilot falls free; he then pulls his chute ripcord.

The installation can also be used as partial protection for a pilot coming in for a crash landing at an altitude too low for effective use of a chute.



Operating sequence employed by the pilot of a disabled airplane in which the ball capsule ejection system is installed.

After Sputnik—What?

(CONTINUED FROM PAGE 39)

relatively low perigees can be sustained for a considerable period. (In late October, NRL was estimating that Sputnik I would last at least 200 days.) This is a conclusion toward which data obtained in recent U. S. rocket experiments has pointed, and apparent confirmation is welcome.

See U.S. Ahead in Research

While impressed by Sputnik I's weight (of which batteries must be a major portion), Vanguard scientists feel confident they'll get as much data –perhaps more–out of their satellite's smaller payload. They believe, furthermore, that the U. S. holds the lead in upper air research. Published data, which must be the criterion, support this contention. Soviet technical studies lean heavily on information obtained by American rocket experiments.

Although they will welcome it if Sputnik's impact on U. S. policy transforms research from a Cinderella to a favored daughter, scientists hope the change will be made sensibly. They favor step-by-step advances to greater knowledge, rather than spectacular stunts. It seems inevitable, for example, that an expanded rocket and satellite program will follow Vanguard. Such an effort, it's argued, should be in terms of useful vehicles, some of which may have a direct meaning for the man in the street, rather than, say, the concept of putting a die marker on the Moon.

More Satellites Ahead

Speculating along these lines, the experts visualize a meteorological reconnaissance satellite that would vastly improve weather reporting, and a radio-TV relay vehicle to make possible worldwide television. There is also the photoreconnaissance satellite for military purposes, an idea in which the Pentagon is displaying renewed interest.

The hope is also being expressed that, in the furor over satellites, the importance of research rockets will not be forgotten. Lay officials, who are now hunting for programs to curtail in order to provide funds for satellite development, will be warned that rockets and satellites are an indivisible team in the search for knowledge of outer space.

Ready, and often eager, to join in the now popular discussion of where space exploration may lead, scientists are at the same time deeply concerned that the public and government officials face some hard facts. They would like people to understand that we are short of scientific manpower, and that scientists can be trained only in a long process that begins in decent grade schools staffed by decently-paid teachers, and continues through secondary schools and universities with similarly adequate budgets. They would like taxpayers, including the Secretary of Defense, to comprehend that it is important to try to find out "why potatoes turn brown." They would like military men to wake up to the fact that, if they emphasize weapons systems to the exclusion of research, they will come a cropper.

In short, scientists hope Sputnik will have taught the country that basic research is vital to survival. If we learn that lesson, time will prove that the Soviets have done us a great service.

Sputnik and Vanguard

(CONTINUED FROM PAGE 32)

vehicle can carry. But the growth factor of a missile is not the only, nor even the most important, criterion of an orbital carrier. Schedule, cost and reliability are at least of equal importance.

The other approach for an efficient orbital carrier is that of starting from scratch. If time allows, a more or less optimistic view could be taken of the present state of the art and of components available now or in the years of development to come. Such an approach will possibly result in the so-called "optimum missile," which is actually nonexistent. It can be no more than an individual or "partial optimum" design. As a matter of fact, there are a large number of "optimums," such as minimum hardware weight per weight unit payload; minimum take-off weight per weight unit payload (growth factor); maximum use of reliable and available components; shortest possible development time; maximum use of existing facilities and manpower (experienced teams); most desirable launching and handling characteristics; mass production aspects; smallest dimensions of vehicle; simplicity and reliability; and many other partial optima.

Missile design and engineering involves nothing more than the ability to find a compromise which satisfies the most important requirements. During development, it is also the "know-how" necessary to eliminate all the "bugs." This is more complicated but little different from any other engineering field. There is no absolute yardstick for an "optimum solution." Opinions, beliefs, estimates and judgment of many individuals are involved.

I am rather sure that the Russians believe that their approach to a satellite carrier is the optimum solution, just as most of the people working on the American Vanguard project probably believe that their approach, with its compromises in optimum growth factor, reliability and schedule, is the "optimum" approach. Both groups might be right from their point of view, but only history will prove which approach was the better one.

Certainly, they will be right who accomplish the job of establishing a satellite with a reasonable lifetime and obtain a reasonable amount of scientific information at the earliest date. They will be honored by history as being the first to accomplish the breakthrough in space flight, which we must believe, will be for the benefit of the human race.

Front Line Fuel Station

LOX semitrailers move in for field operation.

Under contract from the Army Corps of Engineers, Air Products, Inc., has developed a series of mobile liquid oxygen plants that will be used to feed Army missiles like the Redstone in actual operational areas. The first units have already been delivered.

The largest of the mobile generating stations consist of four semitrailers and produces approximately 20 tons of liquid oxygen per day. The oxygen is 99.5 per cent pure when produced at normal atmospheric pressure at 50 per cent relative humidity. The generator takes about 920 lb of diesel fuel per hour, yields 2 lb of LOX for every pound of fuel oil consumed.

government contract awards

Navy Lets $47 Million Talos Job to Sperry

More than $47,000,000 in contracts for Talos missile guidance systems have been awarded to Sperry Gyroscope Co. by the Navy. The equipment ordered is SPG-49 radar systems. Previously, Sperry had received contracts totaling $52,000,000 for SPG-5 Terrier missile guidance systems.

$62 Million Polaris Contract to Lockheed

A $62,100,000 contract for continued development of the Navy's fleet ballistic missile, Polaris, has been awarded to the Missiles Systems Div. of Lockheed Aircraft Corp. The contract will carry this program through Fiscal 1958. Lockheed had previously won a contract for $20,500,000 for initial research, development and testing phases.

Rear Adm. William F. Raborn, director, Special Projects Office, BuOrd, said the Polaris program is being brought forward as rapidly as possible, and will be the nation's first ballistic missile to be assigned to specially equipped naval ships.

AMF Gets $2.5 Million Bomarc Contract

American Machine & Foundry Co. has been awarded a $2.5 million contract by Boeing Airplane Co. for launching and handling equipment for the IM-99 Bomarc antiaircraft missile. Boeing holds a $139.3 million Air Force contract for quantity production of the Bomarc.

SYNOPSIS OF AWARDS

The following synopsis of government contract awards lists formerly advertised and negotiated unclassified contracts in excess of $25,000 for each Air Force, Army and Navy contracting office:

AIR FORCE

Commander, Hq. AMC, Wright-Patterson AFB, Ohio.

Research and development of an aeronautical series of wrenches of open end, box end and socket type for very high-performance aircraft and missile applications, $77,210, **Overton Gear & Tool Corp.**, 736 Interstate Rd., Addison, Ill.

Hq., AF Office of Scientific Research, ARDC, Washington 25, D. C.

Research on flow problems at high Mach numbers, $86,497, **Polytechnic Institute of Brooklyn,** 99 Livingston St., Brooklyn 1, N. Y.

Research on wave superheater, $94,990, **Cornell Aeronautical Laboratory, Inc.,** 445 Genesee St., Buffalo 21, N. Y.

Research on sponsored titanium program, $950,000, **Battelle Memorial Institute,** 505 King Ave., Columbus, Ohio.

Continuation of experimental research on the electronic properties of nonmetallic crystals, $26,760, **University of Illinois,** Urbana, Ill.

Continuation of research on diffusion in semiconductors and related problems, $40,000, **University of Illinois,** Urbana, Ill.

Continuation of research and reports concerning effects of a diffusing gas on aerodynamic heating at supersonic speeds, $26,000, **Massachusetts Institute of Technology,** 77 Massachusetts Ave., Cambridge 39, Mass.

Continuation of research on theoretical and experimental studies of mass transfer cooling, $108,407, **University of Minnesota,** Minneapolis, Minn.

Continuation of research and reports concerning honeycomb sandwich structures, $47,825, **University of Minnesota,** Minneapolis 14, Minn.

Hq., Mobile Air Materiel Area, Brookley AFB, Ala.

Installation of complete communications system to support the Gulf missile testing range, Eglin AFB, Fla., $1,887,053, **Philco Corp.,** Government & Industrial Div., 4700 Wissahickon Ave., Philadelphia 44, Pa.

ARMY

Corps of Engineers, U. S. Army, Office of the District Engineer, Jacksonville Dist., 575 Riverside Ave., Jacksonville, Fla.

Construction of booster storage igloos for complex 25, Navy FBM (Polaris), AF Missile Test Center, Patrick AFB, Florida, $143,175, **Paul Smith Construction Co.,** PO Box 2866, Orlando, Fla.

Corps of Engineers, U. S. Army, Office of the District Engineer, Philadelphia Dist., 2635 Abbottsford Ave., Philadelphia, Pa.

Construction of addition to rocket storage, checkout and assembly bldg., at Dover AFB, Del., $197,608, **Mt. Cuba Construction Co.,** Mt. Cuba, Del.

New York Ordnance Dist., 180 Varick St., New York 14, N. Y.

Research in the mathematical theory of subsonic and transonic fluid dynamics, **New York University,** 25 Waverly Pl., New York 3, N. Y.

Research and development of the Nike-Zeus (Nike II) guided missile system, $5,086,481, **Western Electric Co., Inc.,** 120 Broadway, New York 5, N. Y.

Redstone Arsenal, Huntsville, Ala.

Hydrogen peroxide, concentration 90%, $98,790, **E. I. Du Pont de Nemours & Co.,** Electrochemicals Dept., Wilmington, Del.

Liquid oxygen, 99.5% type II, $76,500, **Linde Co.,** Div. of Union Carbide Corp., 2900 Cahaba Rd., Birmingham, Ala.

Development and delivery of modified XM10 rocket motors, $179,984, and research and development of two-level thrust population unit for Hawk, $153,957, **Thiokol Chemical Corp.,** Trenton, N. J.

Oxygen, liquid, 99.5% type II, $48,450, **Linde Co.,** Div. of Union Carbide Corp., 2900 Cahaba Rd., Birmingham, Ala.

U. S. Army Ordnance Dist., Los Angeles, 55 S. Grand Ave., Pasadena, Calif.

Dart antitank guided missile, $403,036, **Aerophysics Development Corp.,** PO Box 689, Santa Barbara, Calif.

Repair parts for Nike system, $129,462, **Douglas Aircraft Co., Inc.,** 3000 Ocean Park Blvd., Santa Monica, Calif.

Research & development work relating to Corporal type III instrumentation, $39,890, **Gilfillan Bros., Inc.,** 1815 Venice Blvd., Los Angeles 6, Calif.

Propellant development, $66,044, **Grand Central Rocket Co.,** PO Box 111, Redlands, Calif.

Corporal missile test equipment, $26,554, **Firestone Tire & Rubber Co.,** 2525 Firestone Blvd., Los Angeles 54, Calif.

NAVY

Dept. of the Navy, Bureau of Aeronautics, Washington 25, D. C.

Gas turbine compressors, $4,175,452, **The Garrett Corp.** (AiResearch Mfg. Co. of Arizona Div.), 402 S. 36 St., Phoenix.

District Public Works Officer, Sixth Naval District, Bldg. 13, U. S. Naval Base, Charleston, S. C.

Additional base and instrumentation facilities at Grand Bahama Island Auxiliary AFB for the AF Missile Test Center offshore facilities, $863,071, **McDonough Construction of Florida,** 8247 South Dixie Highway, Miami, Fla.

Navy Dept., Bureau of Ordnance, Washington, D. C.

Flash signals and adapters for telemetering pack and flash signals for exercise head for Sparrow III guided missile, $67,138, **Bermite Powder Co.,** Saugus, Calif.

Rockets, components and associated equipment, $75,000, **Century Engineers, Inc.,** Burbank, Calif.

Navy Purchasing Office, U. S. Naval Supply Activities, Brooklyn 32, N. Y.

Ballistic cams and plugs, $25,719, **American Bosch Arma Corp.,** Arma Div., Roosevelt Field, Garden City, N. Y.

Purchasing Office, Dept. of the Navy, Bureau of Aeronautics, Washington 25, D. C.

Jet flap test stand, $163,030, **The Martin Co.,** Baltimore 3, Md.

Dog in Space

(CONTINUED FROM PAGE 31)

altitudes, studies of the dog may produce significant information about cosmic ray effects and weightlessness. The Russians have already said the dog is being fed artificially through a tube, which indicates the animal is in a weightless state.

The experiments involving the dog are largely physiological, and seem to be directed toward learning the mechanics of protecting living beings in space. Since hits by micrometeorites can be expected frequently, the length of time the dog remains alive in the capsule would offer one clue as to how efficient the space cabin is.

One problem which may result if the capsule containing the dog is safely brought back to earth is a legal one. Since no action on space law has been taken, a question might arise as to ownership of the capsule if it came to earth in some country outside of Russia.

Space law authority Andrew G. Haley, questioned on this point during a lecture he delivered at Princeton University last month, said with a smile that he figured the dog would belong to the first woman who saw it. He added that, legally, the capsule would, of course, belong to the Russians.

Missile Market

(CONTINUED FROM PAGE 48)

. . . . . *Emerson Electric* predicts a 33 per cent increase in backlog at end of fiscal 1957, another 30 per cent increase by end of fiscal 1958, doubling of 1958 volume "over the next few years."

Nine-month earnings:

	1957	*1956*
American Bosch Arma	$2.26	$1.77
Bell Aircraft	1.16	1.73
Douglas Aircraft	7.03	5.56
General Tire	1.61	1.17
Lockheed Aircraft	3.83	3.72
Martin Co.	2.22	2.58
Raytheon Mfg. Co.	1.15	—
Thiokol	2.08	1.35
Thompson Products	3.73	2.66

Atomic Clocks Envisioned For Space Navigation

Research with miniaturized atomic frequency standards (atomic clocks) will provide the key to solving many of the problems of space navigation, according to Eugene F. Grant, vice-president of engineering, National Co., Inc.

Grant stated that the Atomichron, first commercially available atomic clock, "represents a thousandfold advance in the state of the art of continuous time measurement. In a space ship, the distance from the earth may be determined essentially by the measurement of the time delay in a pulse of radio energy from an earthbound transmitter and the directional angles from the time relation of rotating radio beams.

"It is envisioned that the space ship will carry a miniature Atomichron that has been synchronized with another Atomichron on the earth, or on a space platform. A computation using the differences in the readings of the spaceborne and earthbound Atomichrons will provide a means of precise location."

FROM: **Colonel John P. Stapp, Chairman, Membership Committee**

TO: **All ARS Members**

During the past year the AMERICAN ROCKET SOCIETY has increased its membership by more than 2500, to a current total of over 7000. This is a remarkable tribute to the growth of interest in rockets, space flight, guided missiles, and, certainly in the ARS.

We still haven't been able to carry the word, however, to thousands and thousands of professionals—colleagues of yours and mine—whose contribution to the field would be significantly greater if they were getting such direct membership advantages as those coming up in the next 12 months:

- **Monthly issues of ASTRONAUTICS**
- **Monthly issues of JET PROPULSION**
- **National meetings in Dallas, Baltimore, Los Angeles, Detroit and New York**
- **Section meetings in 35 different centers of rocket and missile activity throughout the U. S.**
- **Membership in two Technical Divisions (choose from Human Factors, Instrumentation and Guidance, Liquid Rockets, Propellants and Combustion, Ramjets, Solid Rockets, Space Flight)**

We ask your help in communicating with these individuals. It takes little argument to convince anyone that the larger the ARS professional membership, the greater the contribution the Society can make to the nation's urgent rocket and space flight programs.

Your cooperation is earnestly requested in sending us the names of people you feel should be ARS members on the coupon below.

Sincerely yours,
John P. Stapp

Clip coupon and mail to Col. John P. Stapp, ARS, 500 Fifth Ave., New York 36, N. Y.

Please send ARS application forms to the following individuals:

Name ....
Affiliation ....
Mail address ....
....

Name ....
Affiliation ....
Mail address ....
....

Name ....
Affiliation ....
Mail address ....
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Name ....
Affiliation ....
Mail address ....
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Your name ....
Your affiliation ....
Your address ....
....

new equipment and processes

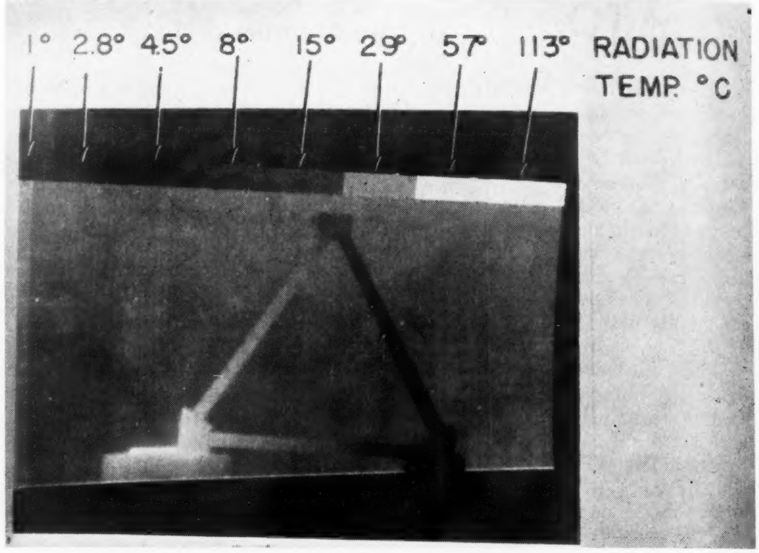
New IR Camera Takes "Heat Pictures"

A NEW infrared camera that takes "heat pictures" was unveiled in New York last month by Barnes Engineering Co. of Stamford, Conn. Called the Barnes Far Infrared Camera, it was developed to take photographs of the infrared radiation, or heat, given off by any object.

The camera first detects the infrared radiation and then converts it into a black-and-white thermal photograph, with each point on the photo indicating the heat being emitted by that point. Light areas correspond to areas emitting the most heat; dark areas indicate less heat. The heat at each point can then be measured by means of a calibrated gray scale, supplied with the photo, which is based on camera settings used when the picture was taken.

Several applications in the missile field were suggested by the company, foremost among these being the study of temperature distribution in models undergoing wind tunnel tests. One unit has already gone out to the General Electric Co. Propulsion Laboratory in Cincinnati, and other wind tunnel engineers have also expressed interest.

It is also expected to be helpful in quality control and testing, since photos of this type can help in the detection of faulty welds, overheating of components and defects in metal castings. Another possible use would be in testing electronic equipment, where deviation from an established normal heat pattern would indicate faulty parts.



HEAT PICTURE. One corner of the metal triangle is on a hot plate, the other on a block of dry ice. Temperatures at various points can be read by comparison with gray scale at top of photo.

Ordinary Film Used

The unit consists of a Barnes Opti-Therm radiometer system for measuring the IR radiation, a scanning attachment and a camera. Special film is not required, since the photographic image is formed by means of an ordinary light beam inside the camera.

In operation, the camera is sighted on an object and an internal mirror scans back and forth across the field of view for several minutes. A sensitive heat detector in the radiometer picks up the radiation emitted by various points on the object and modulates a light beam which is then scanned over the film in a corresponding pattern.

This produces a picture made up of a series of closely spaced lines. Scanning time varies with the detail and sensitivity required and ranges from 2 to 15 minutes. Objects pictured in the photos are clearly identifiable, although black-and-white shading corresponds to gradations of emitted heat intensity, rather than reflected light, as is the case in a conventional photo.

Sensitivity of the camera is said to be very high, with detection of temperature differences as small as 0.02 C claimed.

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EQUIPMENT

Time Code Generator: Employing transistor-driven magnetic cores, an airborne time code generator is being produced for missile and aircraft instrumentation. The unit supplies a 16-bit, 24-hour binary code to hours, minutes and seconds. Signals generated are suitable for recording timing marks or time codes on magnetic tape and oscillographs or to energize neon lights for indicating time code on the edge of motion picture film in optical equipment. Electronic Engineering Co. of California, 180 S. Alvarado St., Los Angeles 57, Calif.

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Sequence Switching System: Designed as a switching device for missile-borne applications, a motor-driven sequencer has been used extensively in two sounding rocket programs for ignition of rocket motors, flares, starting of missile-borne recording equipment, and sequencing of internal instrumentation calibration signals. The system consists of miniaturized d-c. motor attached to a planetary gear box which rotates a wiper arm across contacts on a printed circuit. It operates during and after acceleration loads in excess of 100 g, and functions at altitudes in excess of 100,000 ft. Era Engineering, Inc., 1009 Montana Ave., Santa Monica, Calif.

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Diamond-Coated Saws: A new line of diamond-coated saws for cutting all types of reinforced plastics has been successfully production-tested in major aircraft and missile plants for the past three years. The saws are available in over 100 types, mounted or unmounted, in diameters up to 24 in. Routing tools are also available with configurations which permit several operations at once, as are similarly processed hole saws in diameters from $^3/_4$ to 6 in. Engineering Dept., O'Rourke Diamond Co., Inc., 11423 Van Owen St., N. Hollywood, Calif.

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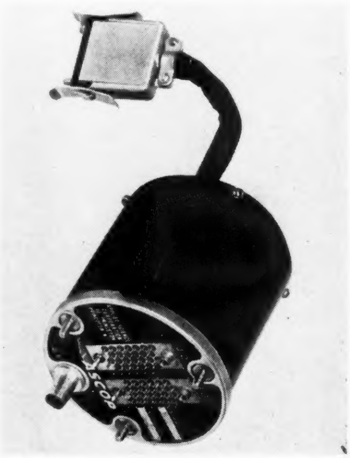
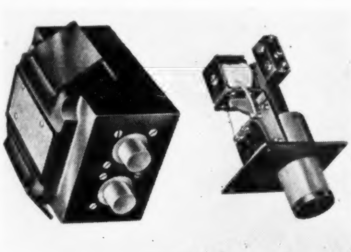
Epoxy Compound: Sample kits of Sealcast 502 epoxy potting compound are available. The compound is a

low-coefficient-of-expansion material which exhibits unusually high electrical resistance at temperatures up to 350 F. It has a wide variety of applications in the missile and aircraft industries, including the potting of transformers, magnetic amplifiers, transistors, circuit boards and recording heads. Minneapolis-Honeywell Plastics Laboratory, 2753 Fourth Ave. South, Minneapolis 8, Minn.



Commutator Gear Box: Model DSG-45 commutates PW information supplied by transducers in airborne telemetering systems. The box contains 43 data contacts and two synchronization contacts. The unit has a mechanical output of 20 rps, samples 43 inputs sequentially, and presents a single pulse train having 43 amplitude modulated channels to a keyer. The two remaining channels are used for frame synchronization. Applied Science Corp. of Princeton, P.O. Box 44, Princeton, N. J.



Igniter and Squib Simulator: To check the ignition and squib circuits in guided missiles and rockets, the ES squib indicator takes the normal current for the normal time and then breaks the circuit just as an igniter or squib would. A translucent button pops out to show that the firing circuit has operated. A mechanical reset makes the device ready for the next test immediately after firing, with no part replacement. Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif.

Thermal Ribbon: Providing a means of electrically detecting, with negligible thermal lag, the temperature of any surface, Minco's thermal ribbons are used in aircraft, missiles and other applications to monitor or control surface area temperatures. The ribbon consists of a resistance element of high nickel content alloy wire encased in a flexible outer covering. Less than 0.020 in. thick, it may be cemented to flat, cylindrical, or irregular surfaces. Minco Products, Inc., 740 Washington Ave. North, Minneapolis 1, Minn.

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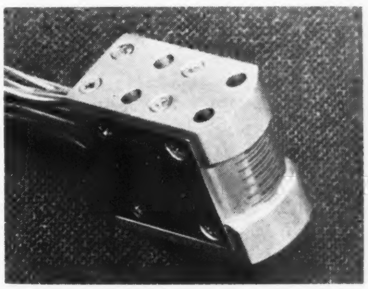
Television Camera Chain: A vidicon television camera chain utilizing subminiature components which meet military specifications is now available. The system's compactness and light weight make it suitable for airborne and other military installations where it is impractical to have human observers. Consisting of a camera head unit, camera control unit, picture monitor unit, power supply unit and remote control unit, the system offers a resolution of 100 per cent modulation at 600 lines. Government Relations Dept., Allen B. Du Mont Laboratories, Inc., 35 Market St., E. Paterson, N. J.



Magnetic Head for Missiles: A newly developed 7-channel magnetic tape recording head can be directly connected to thermocouples to record without the use of amplifiers, using only 20 microwatts. Since the complete system is carried aboard a missile, the head was designed to withstand high shock and vibration forces, as well as high temperature and thermal shock. Data Storage Devices Co., 7828 Burnet Ave., Van Nuys, Calif.

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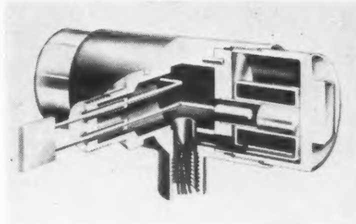
Solid Film Lubricant: Tests have been completed on a one-coat, corrosion-resistant solid film lubricant known as 66-C. Its coefficient of friction is less than 0.04 and it has withstood a 1300-hr salt spray test over anodized aluminum. This coating is a built-in dry film lubricant for operation of missiles in temperatures ranging from −65 to 600 F. Electrofilm, Inc., P.O. Box 106, N. Hollywood, Calif.



Level Control: Model CL-10 Dynatrol gives accurate high or low point detection or narrow range proportional control of liquid, solid and slurry levels. Positive acting electrical output control signal varies with amount of immersion of 120 cycles per sec vibrating paddle in medium being detected. Output signal can be used to control operation of any type of electrical equipment. Automation Products, Inc., 3030 Max Roy St., Houston 24, Tex.

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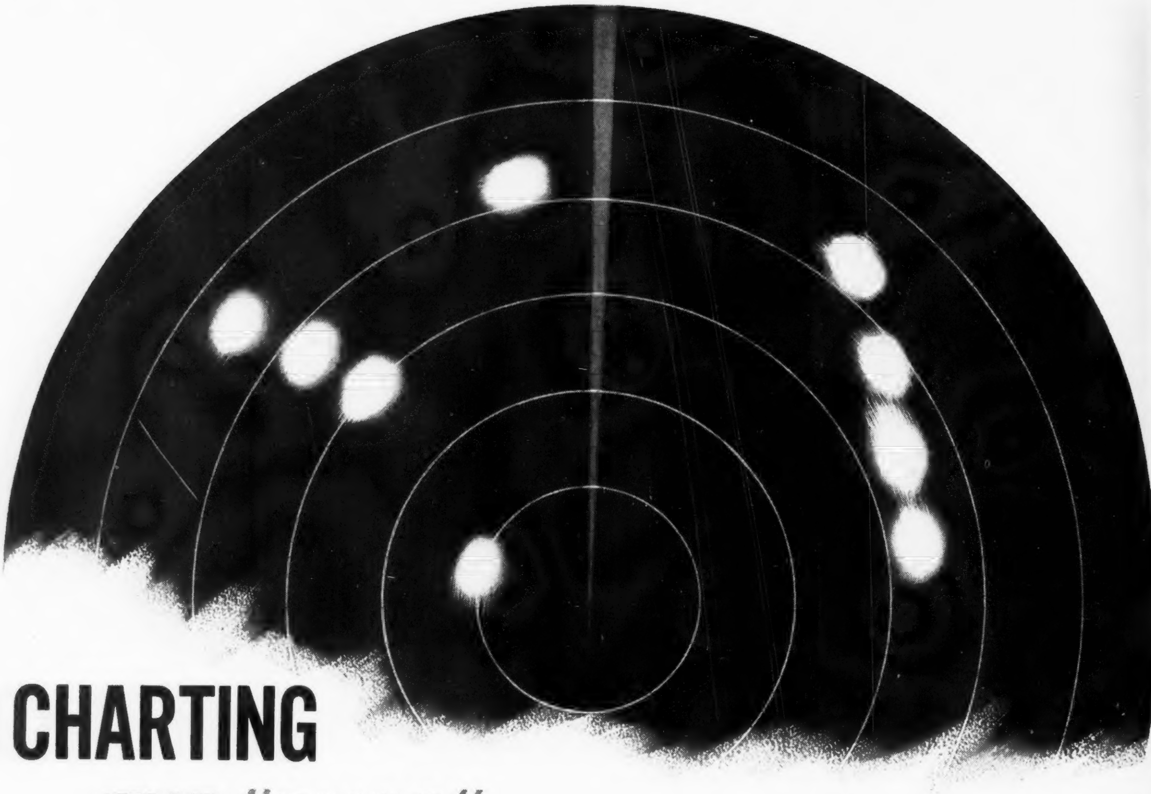
Cleaning Solvent: A safety cleaning solvent is now being offered for wipe or dip cleaning of machine parts and electrical equipment. It replaces carbon tetrachloride and other chlorinated solvents and has no flash point under normal usage. Harco Chemical Co., Cranford, N. J.



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